Copy to Mike Lee
Doug Liden

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, Ca. 94105-3901

JAN 12 1993

Steven L. Costa
Project Manager
CH2M Hill
1111 Broadway
P.O. Box 12681
Oakland, CA 94604-2681

Re: Approval of the Joint Cannery Outfall Dye Study Plan

Dear Dr. Costa:

We have reviewed your letter of December 29, 1992, which provides responses to our comments on the Draft Cannery Outfall Dye Study Plan. We find that the concerns raised by Dr. Walter Frick have been adequately addressed and that the only revision to the draft plan originally submitted is contained in the response to Paragraph 4 regarding the field procedures of vertical profiling. Thus the dye study plan, as submitted with the response to comments, is hereby approved.

Should you have any questions regarding approval of this plan, please contact Pat Young, Office of Pacific Island and Native American Programs, at (415) 744-1591.

Sincerely,

Terry Oda
Chief, Permits Issuance Section
Water Management Division

cc: Norman Wei, Star-Kist Seafood Company
James Cox, Van Camp Seafood Company
Director, American Samoa EPA

1ST Dye Study Sched. for Feb. 93

1/4/93 sm
Cpy to M. Lee
Doug Liden

Engineers
Planners
Economists
Scientists

29 December 1992

PDX30702.DY

Patricia N.N. Young
American Samoa Program Manager
Office of Pacific Islands and Native American Programs
U.S. Environmental Protection Agency
75 Hawthorne Street (E-4)
San Francisco, California 94105

Dear Pat:

Subject: Joint Cannery Outfall Dye Study Plan

Attached is the final dye study plan for the first of the dye studies of the Joint Cannery Outfall in Pago Pago Harbor, American Samoa. The final plan consists of a response to Dr. Frick's comments and concerns and the previous draft study plan. Since there were no changes or significant additions to the draft plan it was not revised and should not need any additional review on your part except for the response to comments section. This study plan meets all requirements of the NPDES permits (Part F of NPDES Permit Numbers AS0000019 and AS0000027).

If you or other reviewers have any questions, please feel free to call me at your convenience. I am sending a copy directly to Dr. Frick as well as Sheila Wiegman.

As indicated in the study plan, the first dye study is scheduled for the first of February. We would like to do the first sediment sampling and the first coral reef survey at the same time. Study plans for those elements will be sent to you for review in a few days.

Thank you for your time and attention to this matter.

Sincerely,

CH2M HILL

Steven L. Costa
Project Manager

cc: Norman Wei/StarKist Seafood Company
James Cox/Van Camp Seafood Company

CH2M HILL 1111 Broadway, Suite 1200, Oakland, CA 94607-4046 510.251.2426 Fax 510.893.8205

JOINT CANNERY OUTFALL DILUTION STUDY PLAN

Including Response to Comments

for

StarKist Samoa, Inc.

and

VCS Samoa Packing Company

to comply with NPDES Permits

AS0000019

AS0000027

December 30, 1992

prepared by

CH2M HILL

JOINT CANNERY OUTFALL DILUTION STUDY PLAN

The joint cannery dilution study plan describes the approach for conducting a wastefield dilution study (dye study) of the effluent discharged from the Joint Cannery Outfall located in Pago Pago Harbor, American Samoa. StarKist Samoa, Inc. and VCS Samoa Packing Company operate and discharge through the outfall. A joint dye study is required as a permit condition under the separate NPDES permits issued to each cannery.

A draft study plan was prepared for review by USEPA and ASEPA. The review found the draft study plan "basically acceptable" with a request to address concerns expressed by Dr. Walter Frick of the USEPA. The draft study plan (Agency Review Draft, 29 October 1992) together with the response to comments provided below, consists of the final dilution study plan. The draft study plan is Attachment 1 to this report and the comments on the draft plan are provided in Attachment 2.

RESPONSE TO COMMENTS

All comments on the draft study plan were provide by Dr. Frick in a memo to Janet Hashimoto, Region IX, USEPA dated 25 November 1992. The following are the responses to his comments and concerns with reference to each paragraph of his memorandum (Attachment 2):

Page 1 - Paragraph 1: He finds the draft plan basically acceptable. His comments express his concerns that the results of the dye study provide information and data appropriate for assessing compliance with permit conditions and American Samoa Water Quality Standards. This is the intent of the dye study. The project staff appreciates Dr. Frick's concerns as discussed below.

Paragraph 2: CH2M HILL project staff are well aware of the limitations, pitfalls, and difficulties of performing field dye studies. The project team that will conduct the study has done 25 to 30 dye studies over the past few years. These dye studies have been conducted under a wide range of environmental conditions in virtually every type of estuarine setting. The location and tracking of the of a dye plume in the manner described is routinely accomplished by project staff. As pointed out by Dr. Frick, there is no practical alternative to the method proposed.

Paragraph 3: Significant overestimates of the dilution are not anticipated by CH2M HILL project staff. Dr. Frick mentions three areas of concern for overestimating the

dilution: water depth variation, vertical current shear, and internal waves. He is concerned that these factors might change the depth and/or location of the dye concentration maximum and the drogue would no longer be an indicator of the depth and/or location of the concentration maximum. The field data collection techniques, as discussed under *Paragraph 4* below, will account for any changes in depth of maximum concentration. With respect to specific items, our understanding of the concerns is as follows:

- The diffuser is located in about 180 feet of water and, based on available current data, it is anticipated that the plume will move approximately parallel to the depth contours. If the plume moves in this fashion, or toward the center of the harbor (southwest), the depth of water will not change significantly. However, if the plume moves toward the reef there may be some significant topographic effects on the plume and the drogue may not follow the maximum dye concentration. Under most conditions the plume will remain submerged, as predicted by dilution models and verified by observation. On encountering the reef wall the plume will be steered shore parallel in shallower water (but not on the reef itself). This could change the depth of maximum dye concentration. Proposed vertical profiling (see Paragraph 4 below) will account for any such behavior and the concentration maximum will be detected and recorded.

- Currents are relatively weak in Pago Pago Harbor and, although vertical current shear could be a factor in determining the plume maximum concentration location, it is not likely that this will be significant. The existence of any significant effect should be reflected in the current meter records above and below the initial trapping depth. The proposed vertical profiling at the mixing zone boundary (see Paragraph 4 below) will result in a record that includes the maximum dye concentrations even if the drogue does not follow the maximum concentration to the mixing zone boundary.

- Internal wave motion or harbor oscillations could result in the vertical or horizontal movement of the plume centerline. It is not anticipated that amplitudes would be sufficient to seriously affect the measurements. However, the proposed vertical profiling (see Paragraph 4 below) will be able to determine if such an effect exists and determine the dye concentration maximum.

All of the items listed above are valid concerns. CH2M HILL's experience and site specific knowledge indicates that the effects will not be significant in terms of defining concentration maximums. Even under conditions under where effects become important, the proposed sampling technique discussed below will be sufficient to

indicate the presence of the effects and determine the actual dye concentration maximum within limits acceptable for the purposes of the dye study.

Page 2 - Paragraph 4: During the collection of field data (dye concentrations) continuous vertical profiles through the plume, using a submerged pump and flow-through operation of the fluorometer, will be made following a drogue. The depth and concentration of the dye maximum will be observable with on board instruments. Therefore, any differences in depth of the drogue and the dye concentration maximum will be obvious and the maximum (with depth) dye concentration will be recorded. This avoids, to the extent possible, most of the concerns raised by Dr. Frick.

In addition, at the mixing zone boundary, continuous vertical profiles will be made at and on both sides of the drogue crossing point. This will be done at a sufficient number of stations along the mixing zone boundary to provide confidence that the actual plume centerline and maximum dye concentration have been determined. In addition to, or in lieu of, repeated vertical profiles, horizontal transects of dye concentration at the depth of maximum dye concentration will be made across the width of the plume.

The procedures described above are standard procedures during CH2M HILL dye studies. The intent is to take whatever action is necessary to define the minimum dilution (maximum dye concentration) at the appropriate location. The attached draft dilution study plan should be interpreted as consistent with this objective and to include the procedures described above.

Paragraph 5: The density gradients used in the previous modeling were based on examination of available data, collected during different seasons, by CH2M HILL and others. Except for rainfall-runoff events which can create a surface layer, density gradients are generally not very "strong" and the "stronger gradient" used for the model is representative. Since the plume from the new outfall diffuser is usually trapped well below the surface, the existence of thin surface layers caused by rainfall events will not directly effect the plume dilution or behavior. Density gradients measured during the time of the dye study will be reported.

Paragraph 6: The modeling used to define the mixing zone did account for "background" concentrations. The modeling effort, which is summarized in the Technical Memorandum referred to in paragraph 5 of the comment letter, accounted for:

- Background concentrations (typical open coast concentrations) expected in the absence of point and nonpoint source loadings in the harbor

- Ambient long term average concentrations (outside the immediate area of discharge) which include background and the effects of all point and nonpoint sources loadings in the harbor, including the canneries (i.e. entrainment and re-entrainment phenomena)

- Effluent plume concentrations during initial dilution calculated by accounting for ambient concentrations (using ambient water for dilution and calculation of an effective dilution)

- Effluent plume concentrations during subsequent dilution calculated by accounting for ambient concentrations (using ambient water for dilution and calculation of an effective dilution)

The mixing zone boundary was established by using a set of complimentary models and considering the interaction of the discharge with the existing concentrations in the ambient receiving water. The modeling is described in more detail in the *Engineering and Environmental Feasibility Evaluation of Waste Disposal Alternatives* prepared for StarKist by CH2M HILL in 1991. The approach used generally follow that described in *Dilution Models for Effluent Discharge* by Baumgartmer et al.

Water quality measurements in Pago Pago harbor in recent years, referred to by Dr. Frick, were made when the both canneries discharged into the inner harbor. The initiation of high strength waste segregation resulted in significant improvements in water quality. However, water quality standards were still exceed throughout much of the harbor, especially in the inner harbor. The present location of the discharge in the outer harbor was selected, based on model predictions, to improve water quality throughout the harbor and meet water quality standards (except within a designated mixing zone). This new outfall has been operating since February of 1992 and indications are that water quality standards are now being met. CH2M HILL has not done a review of monitoring data since the new outfall became operational, but this review, and model verification, will be done as a permit condition (see Sections E and J of the NPDES permits for both canneries).

Paragraph 7: The circulation pattern described, of wind driven inflow at the surface and a return outflow at depth, was based on available current meter and drogue tracking data and is a description of typical long term (net) flow patterns. More description is provided in the Feasibility Study report referenced above. Outflow on the surface in response to rainfall-runoff events is observed and is superimposed on the long term patterns. The dye study combined with the long term monitoring data will provide a better picture of the flow patterns in the harbor. It is unlikely that a single dye study, by itself, will directly provide much new insight into the overall long term net flow characteristics of the system. The model verification study will use both long term monitoring data and dye study data to address this concern.

Paragraph 8: Dr. Frick's comments were appropriate and useful in review of the dye study plan, and other studies required as permit conditions. The above descriptions were intended to address each of the concerns expressed in Dr. Frick's memorandum. The description of field techniques in Paragraph 4 above constitutes the only revision or addition to the text of the draft dilution study plan. Paragraphs 5 and 6 do not directly address the objectives of the dye study but are useful and important points that will be addressed in another study under the existing NPDES permits.

ATTACHMENT 1

Draft Dye Study Plan

AGENCY REVIEW DRAFT

JOINT CANNERY OUTFALL DILUTION STUDY PLAN

Dye Study

for

StarKist Samoa, Inc.

and

VCS Samoa Packing Company

to comply with NPDES Permits

AS0000019

AS0000027

October 29, 1992

prepared by

CH2M HILL

AGENCY REVIEW DRAFT
29 October 1993

JOINT CANNERY OUTFALL DILUTION STUDY PLAN

INTRODUCTION

This dilution study plan describes the approach proposed for conducting a wastefield dilution study (dye study) of the effluent discharged from the Joint Cannery Outfall (JCO) located in Pago Pago Harbor, American Samoa. StarKist Samoa, Inc. (SKS) and VCS Samoa Packing Company (VCS) operate and discharge through the outfall. The study plan describes the data to be collected and methods proposed to collect the data. The quality control and quality assurance procedures and the types of data processing are also described.

PURPOSE

The purpose of this study plan is to propose a joint cannery dye study, consisting of two field efforts, to USEPA and ASEPA for approval. The purpose of the proposed dye study is collect the necessary data to better understand the fate of the effluent plume. The data to be collected are intended to provide direct evidence of plume behavior and to provide information to be used to verify model predictions of dilution and dispersion of the wastefield.

BACKGROUND

The canneries began discharging their treated wastewater, after high strength segregation, into the outer harbor in February of 1992. This is a new outfall that replaces individual inner harbor discharges. Newly issued NPDES permits are based on an approved zone of mixing. The size and location of the zone of mixing was based on environmental and engineering studies which included model predictions.

The NPDES permits issued to each cannery require two dye or tracer field studies. These studies are described in Part F of permit numbers AS0000019 and AS0000027. The effective dates of the permits are 27 October 1992. The permit condition is identical for both canneries and reads:

> *Within one week of the effective date of this permit, the permittee shall submit a plan to the ASEPA and EPA to perform dye and/or tracer studies in order to better understand the fate of the effluent plume. The permittee shall perform these studies twice for one year (once during each of the two primary seasons of the year) and submit its findings 30 days after conducting*

> *each study. The date of the first study must be approved by USEPA and ASEPA and shall occur at the earliest possible time a distinct oceanographic season is in effect and no later than four months of the effective date of the permit.*

In the response to comments on the draft NPDES permits EPA indicated that the first study "is to occur no later than six months after the issuance of this permit." This plan proposes the first field study be conducted in February 1993 and the second in September 1993. Therefore the first field study is proposed to be within four months of the effective date of the permit.

APPROACH

This study is designed to obtain accurate measurements of dye injected and completely mixed into the effluent (wastewater tracer) and released through the outfall diffuser. The dye study is intended to provide direct measurements of nearfield and farfield dilution. Dilution of the wastewater will be determined by continuously injecting fluorescent dye into the discharge at a controlled rate for a period of approximately 13 hours. The horizontal and vertical distribution of the resulting plume will be measured throughout a tidal cycle during daylight hours. Environmental parameters that influence plume buoyancy and trajectory will also be measured and recorded including: current speed and direction, tide height, water temperature, conductivity (salinity), and wind speed and direction. Dilution ratios and effluent concentrations will be determined at the edge of the designated zone of mixing, within the zone of mixing, and at various distances beyond the zone of mixing.

The study will be performed during the two distinct oceanographic seasons, tradewind and non-tradewind, and include, to the extent possible, periods of critical receiving water conditions (such as low slack water and tide reversal) that represent the "worst case" for effluent dilutions. However, the circulation and currents in Pago Pago are largely wind driven, and the times of critical periods are not completely predictable. The data collected during the dye study will be used to verify previous modeling in a separate study (Part J in the NPDES permits). The models used were applied to critical conditions, and verification of the models with dye study data will provide the desired confidence in wastefield dilution and transport predictions for worst case conditions.

Field data will be processed and presented in graphical and tabular formats and described in dilution study reports. An interim report will be written and submitted within 30 days of the first dye study and a final report within 30 days of the second study. Supporting data will be included in the report appendices. The data analysis will include evaluation of the measured dilutions and concentrations in terms of compliance with American Samoa water quality standards.

STUDY PERIODS

It is desirable to conduct dilution studies during "critical conditions". Critical conditions are defined as those environmental conditions that result in the lowest initial dilution for the effluent flow of interest. The most important environmental parameters involved are current speed and direction, water depth, and density variations in the vertical direction. For the JCO in Pago Pago Harbor critical conditions are not easily targeted since the currents are generally wind driven, the outfall is deep so the plume is generally trapped below the surface, and the receiving water density gradients are small.

The dye study will be conducted over a tidal cycle to evaluate, if possible, the effect of tidal variations. Variations of environmental parameters over a tidal cycle are small. Most of the environmental variability is found on a seasonal basis. Two distinct oceanographic seasons represent the extremes in current patterns and density structure in Pago Pago Harbor. The non-tradewind season is most pronounced in January and February. The first dye study is targeted for the first week in February. This schedule may change but the study will be conducted within the January-February window. The tradewind season is most pronounced in May through October. August is, on the average, the most intense of the tradewind months and the middle of August is the target date for the second dye study.

STUDY METHODS

The elements of a dye study include injecting dye into the effluent stream to produce known initial concentrations and measuring the subsequent concentrations of dye in the receiving water. The environmental parameters important to the dilution and dispersion processes are also measured to provide a basis for interpreting the results and characterizing the behavior of the wastefield plume. This section of the study plan describes the methods proposed to carry out the elements of the study.

DYE INJECTION

A 20 percent aqueous solution of Rhodamine WT dye will be used as the tracer. This dye is a fluorescent, water soluble, biodegradable tracer that can be accurately measured in extremely small concentrations, typically less than 0.2 part per billion (ppb). A peristaltic, variable-rate laboratory pump (or a variable stroke injector pump) will be used for dye injection. The pump will be calibrated by direct volumetric measurement of dye pumped before and after the study.

Dye Injection Location

Dye will be injected at a point to be determined, at either SKS or VCS, based on available and appropriate injection locations. The final decision on a dye injection point will be determined on site during field mobilization. Effluent flow rates for both canneries will be monitored during the dye study to facilitate any required adjustments in dye injection rate. Initial dye concentrations will be measured from samples extracted from the outfall pipeline through a sampling tap to be installed downstream of the VCS inflow. The sampling port will be a sufficiently far downstream of the injection point to allow the dye to become well mixed with the effluent.

Dye Injection Time

Dye injections will occur over a tidal cycle (about 13 hours) to provide for direct measurements of nearfield and farfield dilutions, and wastefield overlap, if any, due to tidal reversals. Dye injection will have to begin prior to field measurements of the effluent plume. Travel time in the pipe is just over one-half hour for maximum (permitted) flows and about 1.5 hours for low (99-percentile) flows. Therefore, dye injection will start approximately an hour prior to the start of field measurements.

Dye Injection Rate

Dye will be injected at a rate sufficient to produce a discharge concentration of approximately 2 parts per million (ppm) or higher. Assuming a practical dye detection limit of 1 ppb above background, it will be possible to accurately map the dye plume to a point where it has been diluted to 2000:1 or more. Background fluorescence and effluent characteristics, determined during fluorometer calibration, may indicate that higher injection rates and effluent dye concentrations are needed. Sufficient dye will be available during the study to increase dye injection if necessary.

Amount of Dye Required

The amount of dye required and the injection rate will depend on the effluent flow rate. Permit limits for the canneries provide for a combined maximum effluent flow rate of 3.62 million gallons per day (mgd). Targeted initial concentrations of 2 ppm will require dye injection rates of 19 ml/min. For a dye injection period of 13 hours this requires about 4 gallons of dye. Additional dye will available to increase injection rates, if necessary, and to provide a supply for the test injection described below.

FIELD DATA COLLECTION

Dye will be released for approximately 13 hours beginning about 1 hour prior to the start of field measurements and end at or shortly before the cessation of field measurements. A test injection for approximately two hours will be conducted the day

prior to the dye test. This test injection will test the injection system, provide an opportunity to test the field sampling equipment, and provide a preliminary assessment of plume trapping levels which will be used to pre-set the drogue and current meter depths. Field equipment requirements for the dilution study, including backup units, are listed in Table 1. A locally chartered vessel will be used to deploy sampling equipment.

A three-person scientific staff will be aboard the vessel to deploy equipment, monitor recorders and record data, and direct sampling activities. One person will be ashore to monitor dye injection and handle any problems with the positioning system. The vessel will be equipped with a hand-held radio in order to allow communication with the dye injection station and cannery personnel.

Field data collection will include the following elements:

- Monitoring of effluent flow rate, dye injection rate, and initial concentration (as described above)
- Positioning with a Mini-Ranger III navigation system, or equivalent (a backup method will be available)
- Drogue releases to indicate the current direction and provide a means of tracking the wastefield as it moves away from the diffuser location
- Vertical profile measurements of dye concentration with depth at selected locations within, at the edge of, and outside the zone of mixing
- Horizontal transect measurements of dye concentration across the width of the wastefield, if possible and appropriate
- Vertical profiles of conductivity and temperature at the same locations as dye measurements and background measurements of conductivity and temperature
- Current speed and direction at two depths (at the diffuser and at the plume trapping level)
- Wind, wave, water level, and general meteorological observations

The first five elements give information on the actual measurement of wastewater dilution and wastefield location. The next three elements are done to record the physical variables of the receiving water and those environmental parameters that control the behavior of the effluent plume.

Dye Injection and Flow Data

Dye pumping rate and effluent flow will be monitored and recorded during the course of the study. The dye pumping rate will be varied, if necessary, to maintain as constant a dye concentration as possible in the effluent. Initial effluent dye concentrations will be measured in duplicate samples taken, at half-hour intervals, downstream of the injection point throughout the duration of the injection periods.

Positioning

Vessel navigation will be done using a Motorola Mini-Ranger III electronic positioning system. A suitable backup system will be available. Use of a Mini-Ranger III will allow maximum flexibility in establishing survey transects and will provide positioning range accuracy of approximately ±2 meters. Three transponder locations will be selected and referenced to horizontal control points. Transponders will be positioned to provide adequate coverage for expected wastefield positions. A map of Mini-Ranger coordinates will be generated locating the diffuser, the water quality sampling stations referenced in the NPDES permits, and the edge of the mixing zone. This map will be used in the field to assist in positioning for dye measurements.

One or two sets of temporary range markers will be set on the shoreline to provide rapid visual positioning of the diffuser location. The diffuser location will be determined from design and/or as built drawings. By marking the diffuser with visual lines of position, in addition to using the Mini-Ranger system, stations can be located quickly.

Drogues will be released at the diffuser location as moving position markers to indicate plume movement. In the vicinity of the diffuser the centerline of the plume will be located by determining the depth of maximum dye concentration. A subsurface drogue, with a surface piercing marker float or flag, will be set for the depth of the plume centerline and released. The drogue will be followed to the edge of the mixing zone, and beyond if necessary, as the dye concentrations are measured. Drogue release points and positions will be recorded according to Mini-Ranger coordinates. Drogues will be recovered at the end of each plume tracking episode.

Dye Measurements

Dye concentrations will be measured with an onboard Turner Designs Model 10 fluorometer, or equivalent. This instrument measures the light emitted from the fluorescent dye solution in response to illumination by a light source in the instrument. The fluorometer will be set up with the appropriate light source and filters for detection of Rhodamine WT dye. The fluorometer will be operated in a flow-through fashion with

the ambient water at a particular depth and location pumped directly into the fluorometer by a submersible pump.

Receiving waters in and around the zone of mixing will be sampled in two modes:

- Vertical Profiles: water is pumped continuously through the fluorometer hose intake, which is lowered and raised in the water column in order to document the vertical distribution of dye at selected profiling stations

- Horizontally Transects: water is pumped continuously from a hose positioned at a constant depth while the vessel runs along a transect line

Dye concentrations, in terms of fluorescence readings from the instruments, will be recorded simultaneously with horizontal position and depth. General observations, physical measurements, and any problems will be documented. Rhodamine WT dye fluorescence is highly sensitive to changes in solution temperature. Receiving water temperature, therefore, will be continuously monitored to enable fluorometer data to be corrected during data processing.

At a minimum, vertical profiles will be taken in the vicinity of the diffuser and, following the drogue trajectories, at the edge of the mixing zone. Profiles will also be taken inside and outside the mixing zone along drogue trajectories, as time permits. Horizontal transects will be taken, at a minimum at the edge of the mixing zone. Additional transects inside and outside the mixing zone will be taken as time permits. Decisions concerning the locations and number of profiles and transects will be made in the field by senior project staff familiar with the oceanography of the harbor and the operation of the diffuser. This will maximize operational flexibility and the usefulness of the data collected.

Initial dilution samples will be diluted as necessary and dye concentrations measured at the end of the field operations. Grab samples may be collected if necessary during the course of the field operations. Initial dilution samples and grab samples will be measured using the fluorometer setup in the cuvette mode.

Water Column Density Structure Measurement

InterOcean S4 current meters, discussed below, moored near the diffuser will continuously measure temperature and conductivity at two fixed depths. A SeaBird SBE 19 conductivity, temperature, and depth unit (CTD) will be used simultaneously with the fluorometer at the position of the fluorometer intake to measure and record water column properties. CTD profiles will be available for the same times and locations as dye concentration profiles. Background profiles, outside the effluent plume, will also be taken before, during, and after the dye study period.

Current Measurements

Current speed and direction measurements will be taken during the study. Two InterOcean S4 current meters will be deployed on a single mooring at the diffuser location. One of the meters will be set about 6 feet from the bottom to measure currents acting directly on the diffuser plumes during initial dilution. The other meter will be deployed at the trapping depth of the plume centerline located as described above. These meters will remain at the same depth throughout the dye study. The mooring will be rigged in the field, probably during the dye injection test, to set the upper meter for the correct depth.

Current speed and direction in the vicinity of the diffuser will also be determined with drogues, which will be released at the plume trapping depth as described above. More than one drogue may be released at the same time. Each drogue will be numbered so it can be traced during the course of the study. At the time of release, the release position will be determined with the Mini-Ranger system. Subsequent position determinations will be made when sampling at the drogue locations. Sequential locations of the drogues will be used to calculate average speed and direction along the drogue trajectories.

General Observations

Wind speed and direction will be measured during the course of the dye study using an instrument on board the vessel. Any existing wind stations will be used, if available, to supplement the on-board measurements. Water level will be determined from a staff mounted on a pier piling or from other available tide elevation sources. One of the S4 current meters is equipped with a pressure sensor which will also provide data on water level variations over the period of the field data collection. General meteorological observations will be noted in a field log.

QUALITY ASSURANCE AND QUALITY CONTROL

OBJECTIVE

The quality assurance and quality control objective for the dye studies is to collect measurements of wastefield dilution and dispersion that are of verifiable and acceptable quality. The following procedures will be used to meet the objective:

- Provide verifiable dye injection rates and initial concentrations

- Provide verifiable fluorometric equipment calibration with pre- and post-fluorometer calibration
- Maintain accurate vessel positioning for wastefield measurements
- Provide equipment redundancy (backup equipment)
- Examine dye injection site and downstream sample collection site to verify proper mixing before initial dilution samples are taken
- Examine all data collected to verify instruments are recording/registering data of acceptable quality
- Examine all processed data and data processing methods to verify that analysis techniques are providing the required information

OPERATIONS PLAN

A detailed operations plan for conducting the dilution ratio study will be developed as the basic element of quality assurance and control activities. The operations plan will be based on CH2M HILL's substantial experience with field dye studies. The operations plan will provide the framework for conducting a technically supportable dye study. The operations plan and associated field protocols will be provided in an appendix to the reports. The operations plan will include a preliminary dye injection and field equipment shakedown exercise the day prior to the dye study.

EQUIPMENT CALIBRATION

All equipment will be obtained prior to the beginning of the dye study. Each instrument will be checked on arrival to confirm that it is in working condition. Each instrument requiring calibration will be calibrated immediately prior to the beginning of the dye study and, when appropriate, following the study. Calibration methods for each instrument are described below. Acceptable factory calibrations will be verified for instruments calibrated by the manufacturer.

Dye Pump

The dye pump will be calibrated at the location where it will be used during the dye study. The flow rate will be calibrated with the dye at ambient temperature by discharging dye into a graduated cylinder for a fixed period of time at various flow rate settings. According to the manufacturer, reproducible metering accuracy of greater than 1 percent can be expected when handling medium-viscosity fluids if fluid differential pressure, fluid viscosity, and electric line voltage remain constant. To verify

that none of these factors is affecting expected dye flow rates during dye injection, dye flow rates will be verified and logged prior to and at the conclusion of dye injection and cumulative dye volume pumped will be logged at 1-hour intervals during injection.

Fluorometers

Fluorometers will be calibrated according to the manufacturer's specification such that they measure total dye concentration in a range of 0.1 to 100.0 ppb. Standards will be prepared with the dye used in the study, effluent from the canneries, and seawater. Seawater will be collected from the study site prior to the dye study, and fluorometers will be calibrated before going into the field. Immediately following the dye study, new calibration curves will be developed using the same standards as in the pre-study calibration. This second set of calibration curves will be compared to the initial calibration data, after correction for temperature. Both calibration curves will be used to correct or adjust the observed dye concentration and dilution.

CTD and S4 Current Meters

The CTD unit and the current meters will be calibrated to the manufacturer's specifications before conducting the dye study. Calibration results will be used during data reduction and calculation of the water column density structure and current fields as required. Calibration histories will be reported for the units used.

Mini-Ranger

The Mini-Ranger will be calibrated to the manufacturer's specifications prior to conducting the dye study. The unit and transponders will be checked against known distances similar to those to be encountered during the study. A calibration range maintained by the National Ocean Service is used for this purpose.

DATA PROCESSING AND PRESENTATION

Field data will be processed and analyzed to determine the measured dilution of the wastefield at various locations inside, at the edge, and outside of the mixing zone. Water column density profile, water levels and current speed data will also be presented. The data will be presented in graphical and tabular formats.

Field data and procedures will be recorded in field logs on the vessel and at the dye injection station. S4 current meter data are recorded internally in the instruments. These data will be downloaded to a portable computer at the end of the day. The CTD data will be monitored and recorded on computer in real time, critical data will be recorded in the field logs. Fluorometric readings will be recorded in the field logs.

fluorometric readings after correction for calibration
data are processed in four steps as follows:

ect fluorometer outputs for temperature

npare pre- and post-calibrations to determine any drift
to make corrections to the conversion between
escence and dye concentration

late initial and plume concentrations using
nation from Steps 1 and 2

late dilutions using concentrations (initial and plume)
Step 3

ented as vertical profiles and horizontal transects.
l be indicated on a base map including the diffuser
ing boundary. Other data will be reported and
ding:

ots of vertical profile measurements of dye, tempera-

d speed and wind direction

ater levels and current speed and direction

ed within 30 days of the first dye study. This report
or study plan modifications, if required, for the second
ding results of both dye studies will be produced within
h reports will include an evaluation of the results with
American Samoa water quality standards. All raw and
in appendices to the dilution study reports.

Table 1
Field Equipment for Dilution Study
(Equivalent or better models may be substituted for some equipment)

Equipment Item	Purpose	Number of Units	Accuracy Standard
Turner Model 10 Fluorometer	Fluorescent dye measurement	2	Detection to 0.1 ppb
Seabird SBE 19 CTD	Measure conductivity, temperature, and depth	1	Conductivity ±0.001 S/m Temperature ±0.001 °C Depth = 0.5% of full scale
Compaq SLT Computer	Set up and record Seabird CTD data	2	4-hour battery (3 packs)
Motorola Mini-Ranger III System	Microwave positioning System 3 transponders	1	±2 meters
MasterFlex Peristaltic Pump	Used for dye injection into effluent at constant rate	2	0.2 ml/min
1/3-hp Submersible Pump	Pumps receiving water from depth through fluorometer	2	230-volt a/c
Motorola Hand-held VHF Radios	Communication ship-to-shore	4	Battery-powered (2-mile range)

ATTACHMENT 2

Comments on the Draft Dye Study Plan

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, Ca. 94105-3901

December 1, 1992

Steven L. Costa
Project Manager
CH2M Hill
1111 Broadway
P.O. Box 12681
Oakland, CA 94604-2681

Re: Review of the Joint Cannery Outfall Dye Study Plan

Dear Steve:

We reviewed the canneries' outfall dye study plan and also had Walter Frick of EPA's Office of Research and Development review the the plan. The plan is basically acceptable. However, Dr. Frick had several recommendations and concerns, which are detailed in the attached memo. One of his concerns was that the proposed plume measurement program might overestimate the dilution achieved and recommended a method to counteract this problem. He also had concerns regarding the modeling used for the mixing zone determination not factoring in background concentrations to establish effective dilution based on the discharge's interaction with the ambient water.

We would appreciate your addressing the concerns raised by Dr. Frick in the dye study plan and subsequent analyses.

Sincerely,

Pat Young

Pat Young
American Samoa Program Manager
Office of Pacific Island and Native
American Programs (E-4)

Enclosure

cc: Norman Wei, Star-Kist Seafood Company
James Cox, Van Camp Seafood Company
Pati Faiai, American Samoa EPA

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT

ENVIRONMENTAL RESEARCH LABORATORY - NARRAGANSETT
HATFIELD MARINE SCIENCE CENTER
NEWPORT, OREGON 97365

November 25, 1992

PACIFIC ECOSYSTEMS BRANCH
TELEPHONE: (503) 867-4040

867-4040
4029

MEMORANDUM

SUBJECT: Review of Draft Dye Study Plan for Tuna Cannery NPDES Permits

FROM: Walter E. Frick
Physical & Chemical Processes Team

TO: Janet Hashimoto
Region IX

I have participated in two separate dye studies and know that Steve Costa is himself familiar with dye studies. Based on this experience and my readings of the draft dye study, I find the plan basically acceptable.

However, all parties should be aware of the limitations and pitfalls of dye study work. I think the study team should be able to locate and sample the plume in the nearfield, as described on page 7, though even this task can be difficult and time consuming. The method of then using drogues to follow the water parcel to make subsequent measurements is a fairly standard technique. Short of intensive and extensive monitoring throughout a large area, I do not know of a better way to track the plume.

Given, however, that the nearfield monitoring accurately depicts plume concentrations, most likely this measurement program will tend to overestimate the subsequent dilution achieved. I can think of three reasons to support this conclusion: 1) The depth of the water varies significantly in the vicinity of the diffuser. Because the water column in which the initial dye measurement is made will stretch as it moves into deeper water, the depth of the plume maximum will maintain its relative position, therefore sinking to a greater depth. Thus measurements at drogue depth will no longer represent the plume maximum. 2) The same effect may be accompanied by vertical current shear so that the location of the plume maximum will also be uncertain. 3) Internal wave motion might change the depth and location of the plume. Finally, if the drogue moves into shallower water there is always the danger of getting caught on the bottom.

Of course, attempts can be made to counteract this problem by taking excursions from the drogue location in the effort to find the local maximum. Since knowledge of what direction is perpendicular to the plume centerline will be uncertain, this technique will also suffer uncertainties. However, the existence and importance of the mixing zone makes other locations less relevant. My recommendation is that as much profiling be done along this boundary as possible, using the drogue crossover point as a guide for concentrating the measurement effort.

In addition to the dye study, I examined the Technical Memorandum "Site-specific Zone of Mixing Determination for the Joint Cannery Outfall Project, Pago Pago Harbor, American Samoa." Assuming the density profiles are representative of the conditions of concern, my own limited modeling resulted in initial similar dilution predictions. I have no knowledge about density gradients in tropical waters but do not find what is called a "stronger gradient" on page 12 very strong compared to gradients elsewhere in coastal and estuarine water. The conductivity and temperature measurement program proposed for the dye study should be used to help ameliorate this concern.

The modeling presented in the mixing zone determination study only establishes overall dilutions. It does not factor in the background concentration to establish effective dilution or concentrations based on the interaction of the discharge with existing polluted ambient water. The new EPA guidance on plume modeling "Dilution models for effluent discharges" (Baumgartner, Frick, Roberts, and Fox, 1992) makes such estimates possible. The water quality measurements for Pago Pago Harbor in recent years indicate that water quality standards are exceeded and are occasionally high enough so that, even when they are not exceeded, the presence of a source may cause exceedances near the mixing zone.

The dye program should also help establish whether flow patterns in Pago Pago Harbor are as anticipated in the dye study plan: inflow at the surface and outflow at depth. This is different from the pattern in many estuaries in which outflow generally occurs near the surface.

I hope that the contractor will address these concerns further in forthcoming analyses of the dye studies.

cc: David Young

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

January 22, 1993

Steven L. Costa
Project Manager
CH2M Hill
1111 Broadway
P.O. Box 12681
Oakland, CA 94604-2681

Re: Review of the Joint Cannery Outfall Sediment Monitoring and Coral Reef Draft Study Plans

Dear Steve:

We have reviewed the draft sediment monitoring and coral reef study plans submitted to us on January 6, 1993. Both studies are required by the canneries' NPDES permits. Generally both plans are acceptable, and address the objectives of the studies as outlined in the permits. Both studies appear to be well planned. We find that the use of the Mini-Ranger for locating sampling sites is an excellent idea.

However, we have the following comments and recommendations which we would appreciate being commented upon and/or addressed in the final plan:

Draft Sediment Monitoring Plan

1. Total Organic Carbon measurements are preferred over Total Volatile Solids (TVS) because it is a better indicator of sediment organic compounds.

2. Total grain size distribution measurements should not be optional as they are an important assessment of solids dispersal in the harbor (i.e., percent silt, clays, sands, etc.).

3. In addition to references mentioned in the plan, other reference documents should be consulted re: collection, storage, analyses, i.e, EPA's 301(h) QA/QC document (EPA 430/9-86-004) and the EPA/COE 1991 Evaluation of Dredged Materials Proposed for Ocean Disposal (EPA-503/8-91/001). If you do not have these documents, feel free to visit our office to review our copies.

4. Have sediment traps been considered? If not, why not? Sediment traps would enable one to determine deposition of new

material over time. Also, a van Veen sediment grab sampler is preferred over a Ponar sampler.

5. Will total and/or water soluble sulfides be measured? What methods will be used? (See 301(h) QA/QC document). Should ammonia also be measured since it is the form of nitrogen that is most readily utilized by phytoplankton and macroalage?

6. How will Eh be measured? (A copy of a suggested procedure is enclosed as Attachment 1.) At what depth will it be measured? If only one measurement will be taken we suggest it be at the 2 cm depth. However, a full vertical profile through the sediments is preferred.

7. Where will temperature and pH be measured? Will they be measured at the surface, 2 cm depth, and at other depths? Please explain the rationale and objectives for measuring pH, Eh and temperature at depth(s) chosen.

8. How will the sediment grab sampler and stainless steel bowls be cleaned between sampling events to minimize cross-contamination between stations?

9. Will only the surface sediments be photographed? If yes, why? We suggest that photographs also be taken of sediment cores as changes in color could then be correlated with other data re: Eh, particle size, hydrogen sulfide, etc.

10. We have no objection to the modification of the monitoring schedule proposed, i.e., having the first two sampling episodes during the first year of the study, six months apart. However, we recommend that the third sampling event occur 12 months after the second episode, versus 18 months as proposed in the study. We feel that the 18-month interval is too long after the second sampling event. Also, a 12-month interval would enable the sampling to take place during the same time as the first event. This should provide information to assist in determining the best season for the annual sampling in the future.

11. Compositing the sediment samples may greatly affect the hydrogen sulfide measurements. Perhaps separate discrete samples should be collected for hydrogen sulfide measurements before compositing.

12. We suggest that a minimum of 2 liters of sediment per station be collected and that excess sediment samples be archived in case there are problems with any of the measurements.

13. The final report on the study results submitted to USEPA and ASEPA should include the following: Introduction, Methods and

Materials, Results, Discussion and Recommendations, and Conclusions.

14. Table 2 on Sediment Chemical Analyses indicates standard methods numbers which are outdated. See 1989 edition of Standard Methods.

Draft Coral Reef Study Plan

The draft plan for the coral reef study is generally good. We especially find noteworthy the use of a Mini-Ranger for siting, use of permanent transects and the adequate number of stations to be surveyed, and the various depths at each station. Our review comments are as follows:

1. Benthic organisms included in the semi-quantitative data sets at each transect should be macroinvertebrates and macroalgae.

2. If possible, water quality sampling should be coordinated with the reef surveys so that any potential correlations between water quality and biological data can be noted. Water quality monitoring should be performed either on the same day or within a week of the coral reef surveys.

3. On page 5, end of the third paragraph, only five representative sites are specified where video records of reef flats will be taken. Where is the sixth representative site?

4. Will the marine ecologist who will be analyzing the videos also be involved in conducting the transects? Please provide a copy of his resume/experience in tropical marine waters.

5. Please describe in detail how the video transect records will be "analyzed and summarized" (see page 2 of the draft plan).

6. We recommend that all sites be visited at least once per year to ensure that the transect marker stakes are still present and/or whether any major changes to each site have occurred.

7. Please describe in detail the video equipment and methods to be used during the videotaping of each transet. This would include information describing:

   a. The camera(s) to be used and "line of resolution" per frame;

   b. Recommended swimming speed for each transect;

   c. Standardized distance from the bottom that will be used during videotaping and the taking of still pictures; and,

d. Any other revelant information.

8. In order to quantitatively document changes within and between the silts over time, we strongly recommend that at least one permanent square-meter quadrant be established along each transect line.

9. For additional guidance in modifying the design of the coral survey plans, please refer to the attached documents entitled: Effects of Sugar Mill Waste Discharge on Reef Coral Community Structure, Hamakua Coast, Island of Hawaii (Attachment 2) and Proposal for Long-Term Monitoring and Management Research on Coral Reefs (Attachment 3).

10. It might be worthwhile to investigate whether a chemical indicator exists in the cannery effluent (e.g., aluminum from the alum added to the wastewater treatment system) which can be measured in the sediment. This would assist in determining transport, dispersion, etc. of the effluent in the harbor.

11. The final report on the study results submitted to USEPA and ASEPA should include the following: Introduction, Methods and Materials, Results, Discussion and Recommendations, and Conclusions.

Also attached are the American Samoa Department of Marine and Wildlife Resources' (DMWR) comments on the sediment monitoring plan and the dye study plan (Attachment 4). We would appreciate your response (in writing) regarding our concerns raised above, and the comments provided by DMWR regarding the draft sediment monitoring plan and the dye study plan. Please call Pat Young at 415/744-1591 if you have any questions.

Sincerely,

James B. Brandt

for Norman L. Lovelace, Chief
Office of Pacific Island and Native
American Programs (E-4)

Enclosures (4)

cc: Sheila Wiegman, American Samoa EPA
Jim Cox, Van Camp Seaffod Company, Inc.
Norman Wei, Star-Kist Seaffod Company

AGENCY REVIEW DRAFT

JOINT CANNERY OUTFALL SEDIMENT MONITORING STUDY PLAN

for

StarKist Samoa, Inc.

and

VCS Samoa Packing Company

to comply with NPDES Permits

AS0000019

AS0000027

JANUARY 6, 1992

prepared by

CH2M HILL

AGENCY REVIEW DRAFT
6 January 1993

JOINT CANNERY OUTFALL DILUTION STUDY PLAN

INTRODUCTION

This Sediment Monitoring Study Plan presents a plan for conducting field collections and laboratory analyses of the marine sediments at seven sites in the inner and outer regions of Pago Pago Harbor, American Samoa. This sediment study plan is required under the conditions of the United States Environmental Protection Agency (EPA) NPDES Permit No. AS0000019 for Star-Kist Samoa, Inc. and NPDES Permit No. AS0000027 for VCS Samoa Packing Company. This document describes the objectives, approach, and field and laboratory methods for sediment monitoring in the harbor.

Section G of the Star-Kist Samoa and Samoa Packing NPDES permits addresses the Sediment Monitoring as follows:

> *"Sediment monitoring is conducted to determine the character of the sediments in relation to long-term high nutrient discharge by the permittee in the harbor and if harbor recovery will be affected by resuspension of the nutrients.*
>
> *The permittee, cooperatively with {Samoa Packing Co.; Star-Kist Samoa, Inc.} shall undertake a yearly sediment monitoring program in Pago Pago Harbor in order to assess the concentration of nutrient and organic components, the distribution of stored nutrients, the size of the nutrient reservoir, and the rate of accumulation of nutrients. Seven sites shall be located within Pago Pago Harbor and analyzed for total nitrogen, total phosphorus, percent organics, percent solids, bulk density, oxidation reduction potential, and sulfides. Three sites shall be located in inner Pago Pago Harbor and four sites shall be located in the outer harbor. These sites and monitoring plan shall be submitted within three months of the effective date of the permit for approval by ASEPA and EPA. Thereafter, these sites shall be approved annually by the anniversary date of the effective date of the permit. A report of the sediment monitoring program findings shall be submitted to the ASEPA and EPA 90 days after completion of sampling.*
>
> *After the first two studies have been performed and the results have been assessed, the permit may be reopened for the inclusion of a more frequent or less frequent monitoring schedule."*

This study plan is being submitted to EPA and American Samoa Environmental Protection Agency (ASEPA) to comply with the NPDES permit condition of Section G.

AGENCY REVIEW DRAFT
6 January 1993

APPROACH

The joint cannery outfall operated by Star-Kist Samoa and Samoa Packing extends a distance of approximately 1.5 miles from the cannery locations on the north shore of the inner harbor into the outer harbor offshore of Anasosopo Point. The outfall consists of a 16-inch HPDE pipe that terminates with a multiport long diffuser section located at a depth of approximately 176 feet below MLLW. The diffuser section has 4 active ports on alternating sides of the pipe at a spacing of 10 feet. The diffuser ports are all 5-inches in diameter and discharge horizontally. The approved zone of mixing zone boundary is defined according to Figure 1 in the NPDES permits.

OBJECTIVES

The objectives of the Sediment Monitoring Study are: (1) to evaluate the characteristics and nutrient load of the marine sediments in the vicinity of the canneries previous (abandoned) outfalls in the inner harbor; (2) to evaluate the characteristics and nutrient load of the marine sediments in the vicinity of the new joint cannery outfall diffuser in the outer harbor; (3) to provide data for an evaluation of changes in harbor sediments over time. Sediments are to be collected from seven sites, three sites proximate to the historic cannery outfalls in the inner harbor, three sites proximate to the new diffuser, and one site at the Utulei outfall discharge site. The relative location of the seven sediment sampling sites are shown in Figure 1.

SAMPLE SITE LOCATIONS

The location of the sampling sites was established based on the predominant current directions at the outfall areas, bathymetry of the area, limited available information on sediment physical characteristics, and the location of point source discharges of nutrients. The wastewater plume behavior and transport direction will be confirmed through the field dye study measurements. The sample sites are shown in Figure 1 and are located as follows:

- Inner harbor site IH-1 will be located within 100 feet of the previous cannery outfalls
- Inner harbor site IH-2 will be located within 500 feet and directly south of the previous cannery outfalls
- Inner harbor site IH-3 will be located at the seaward end of the inner harbor
- Outer harbor site OH-1 will be located about 400 feet NNE of the new outfall diffuser

- Outer harbor site OH-2 will be located about 400 feet SSW of the new outfall diffuser
- Outer harbor site OH-3 will be located directly across the harbor from OH-1 and OH-2
- Outer harbor site OH-4 will be located seaward of the outfall diffuser at the seaward end of the outer harbor

DATA COLLECTION AND ANALYSIS

Five separate samples will be collected at each sampling site and then composited to provide a single representative composite sample for chemical analyses. The field collections for the sediment studies will started in early February 1993, after plan approval by EPA and USEPA. The sediment physical characteristics at each sampling site will be described and photographed in the field.

Chemical analyses will include those listed in the NPDES permit, using analytical and QA/QC procedures provided in the Standard Methods for the Examination of Water and Wastewater (1989) and Procedures for Handling and Chemical Analysis of Sediment and Water Samples (U.S. EPA and Army COE, 1981).

Field and laboratory analytical data will be processed and presented in tabular formats in a sediment monitoring study report, and supporting data will be included in the report appendix.

MONITORING SCHEDULE

The NPDES permits specify yearly collections of sediment. CH2M HILL and the canneries have proposed to modify this schedule without decreasing the number of monitoring episodes. The modification provides for the first two sampling episodes to be made during the first year of the study about six months apart, the third sampling episode to be during the third year, approximately 18 months after the second, and subsequent collections annually thereafter or as determined after review of initial results.

The advantages to this modification include:

- A compressed time interval when sediment characteristics are expected to change most rapidly near the previous discharge locations in the inner harbor. Changes in sediment nutrient concentration near the previous outfalls can be expected to vary in a fashion similar to a first order decay phenomena. Most

of the change will be soon after the source removal (cannery discharge). With time the rate of change will probably slow. Therefore, a sampling schedule with more frequent samples at the beginning may better track the changes.

- A compressed time schedule for the initial collections near the new outfall location will provide a better baseline characterization of the sediment characteristics.

- The modified schedule will allow CH2M HILL staff doing the dye studies during year one to be directly involved in the sediment monitoring study and provide an opportunity to train personnel that might do similar collections in the future.

STUDY METHODS

The sediment monitoring study requires field data and sample collection and subsequent laboratory analysis. The methods to be used for these elements of the study are described below. The field work described in the following sections include the methods and equipment to be used for the field collection of sediments, station positioning, sample handling, and sample shipment. The Laboratory analysis methods listed are compatible with the NPDES permit requirements.

FIELD EQUIPMENT AND SAMPLING VESSEL

Field equipment requirements for the sediment sampling are listed in Table 1. A work vessel with a two-person scientific staff will be aboard to collect sediment samples by hand, since no vessel with hydraulics is available in American Samoa.

STATION LOCATIONS AND FIELD POSITIONING

Sediment samples will be collected from a work vessel using five separate grab samples at each of the seven sites. Vessel navigation will be done by using a Motorola Mini-Ranger III electronic positioning system. Use of a Mini-Ranger III will allow maximum flexibility in establishing sampling locations and will provide range accuracy of approximately ±2 meters. A marker buoy will be deployed at the precalculated Mini-Ranger position of the new outfall diffuser prior to collecting sediment samples at the outer harbor outfall sites.

SEDIMENT SAMPLE COLLECTION

Sediment sampling will be conducted in accordance with the Procedures for Handling and Chemical Analysis of Sediment and Water Samples (U.S. EPA and Army COE, 1981). Sediment samples will be collected using a 0.0225 square meter Petite Ponar grab sampler. The Petite Ponar sampler is a weighted sediment grab sampler designed to penetrate and collect undisturbed samples of sediments ranging from silts to coarse gravels. This type of sampler has been used previously to collect sediment samples throughout Pago Pago Harbor. The grab sampler should be able to penetrate and provide a reliable sediment sample of a minimum depth of 4 cm.

Samples will be collected with a minimum of five separate grabs at each of the seven sites. Sufficient sediment materials will be collected at each site to provide adequate material for the sediment chemistry analyses. More than five grabs will be taken if required to collect sufficient material. If the is hard or rocky, has no sediment, or bottom conditions at a site prevent sediment from being recovered, the site will be relocated based on the judgement of experienced scientists on the project staff.

Prior to disturbing the grab samples the following will be recorded in the field logbook: sediment sample penetration depth, color, texture, odor, temperature, pH, and Redox potential. The five (or more) samples from a single site will be composited in a stainless steel bowl, and samples will be taken from the composite for sediment chemistry analyses. The total of seven composite sediment samples for sediment chemistry analysis will be collected.

Samples collected at each site will be labeled with a unique designator to allow sample tracking; each sample designator will consist of a two-letter location code (IH or OH), followed by a numerical station code (1 through 7). Samples for chemical analyses will be immediately iced and/or preserved (as required) and prepared for shipment to the laboratory. The laboratory selection will be finalized prior to field sample collection

LABORATORY ANALYSES

Each composited sediment sample will be analyzed for the chemicals listed in Table 2. All sample collections will be performed in accordance with the Procedures for Handling and Chemical Analysis of Sediment and Water Samples (U.S. EPA and Army COE, 1981). Sample containers, sample handling requirements and sample preservation requirements are listed in Table 3.

AGENCY REVIEW DRAFT
6 January 1993

QUALITY ASSURANCE AND QUALITY CONTROL

The quality assurance and quality control objectives for the sediment studies are to collect representative sediments surface samples and provide laboratory chemical and physical measurements that are of known and acceptable quality. The following requirements will be followed to meet the objectives:

- Provide verifiable laboratory chemical analyses with QA to evaluate accuracy and precision targets
- Maintain and document accurate vessel positioning for sample collection
- Provide field equipment redundancy (backup equipment)
- Develop and use a field operations plan
- Examination of samples as collected and subsequent data by experienced scientists

FIELD OPERATIONS PLAN

A field operations plan for conducting the sediment sample collections will be developed as the basic element of quality assurance and control activities. The operations plan will include field data sheets, chain of custody forms, and a sample matrix collection checklist.

EQUIPMENT CALIBRATION

All equipment will be obtained prior to the beginning of the sediment studies field collections and checked to verify correct operation. Any instrument requiring calibration will be checked and calibrated upon its arrival to confirm that it is in working condition.

The Mini-Ranger will be calibrated to the manufacturer's specifications prior to conducting the dye study. The unit and transponders will be checked against known distances similar to those to be encountered during the study. A calibration range maintained by the National Ocean Service is used for this purpose.

DATA ANALYSIS AND PRESENTATION

Field data will be summarized and vessel positioning data will be processed to calculate and plot the sediment sampling locations. Laboratory chemical and physical data will be reviewed to determine whether analytical accuracy and precision targets were achieved and to assess the laboratory quality assurance. Sediment chemistry results will be presented in tabular formats.

A report of the results will be provided to EPA and USEPA following each monitoring episode (within 90 days of the field sampling). Any proposed revisions to the study plan will be presented in the monitoring report. Review comments from EPA and ASEPA will be incorporated into the revised study plan as appropriate.

Table 1
Field Equipment for Sediment Field Collections

Equipment Item	Purpose	Number of Units	Accuracy Standard
Work Vessel	Field Sampling Platform	1	N/A
0.02 meter^2 Petite Ponar Sediment Grab Sampler	Collect sediment samples at depth	1	Sediment grab acceptability of 4 cm depth
Motorola Mini-Ranger III System	Microwave positioning System with 3 shore-based transponders	1	±2 meters
ASTM brass sieves	Wet sieve sediments from samples	2	N/A
Orion Redox Potential and pH Instrument	Measure sediment oxidation-reduction potential and pH in the field	1	±0.5 millivolts
Sample Containers	Collections of sediments for chemical analyses	As required in plan	Pre-cleaned sample containers
Ice Chests	Sample jar holder, cool samples on ice, and sample shipment	As required in plan	Pre-cleaned containers

Table 2
Sediment Chemical Analyses

Parameter	EPA Method	Standard Methods No.
Total Kjeldahl Nitrogen	175	437
Total Phosphorus	249	481
Sulfides	284	505
Total Volatile Solids (Percent Organics)	272	95
Percent Solids	270	91
Bulk Density	TBD	TBD
Particle Size (Optional)	None	250 g

Table 3
Sediment Sample Collection and Handling Requirements

Parameter	Holding Time	Minimum Sample Size	Preservation	Sample Container
Total Kjeldahl Nitrogen	7 days	10 g	Cool, 4°C	250 ml plastic jar
Total Phosphorus	7 days	10 g	Cool, 4°C	250 ml plastic jar
Sulfides	7 days	20 g	Cool, 4°C, add 2 ml ZN-acetate	250 ml plastic jar
Total Volatile Solids (Percent Organics)	14 days	100 g	Cool, 4°C	250 ml plastic jar
Percent Solids	None	50 g	Cool, 4°C	N/A
Bulk Density	None	50 g	Cool, 4°C	N/A
Particle Size	None	250 g	Cool, 4°C	250 ml plastic jar

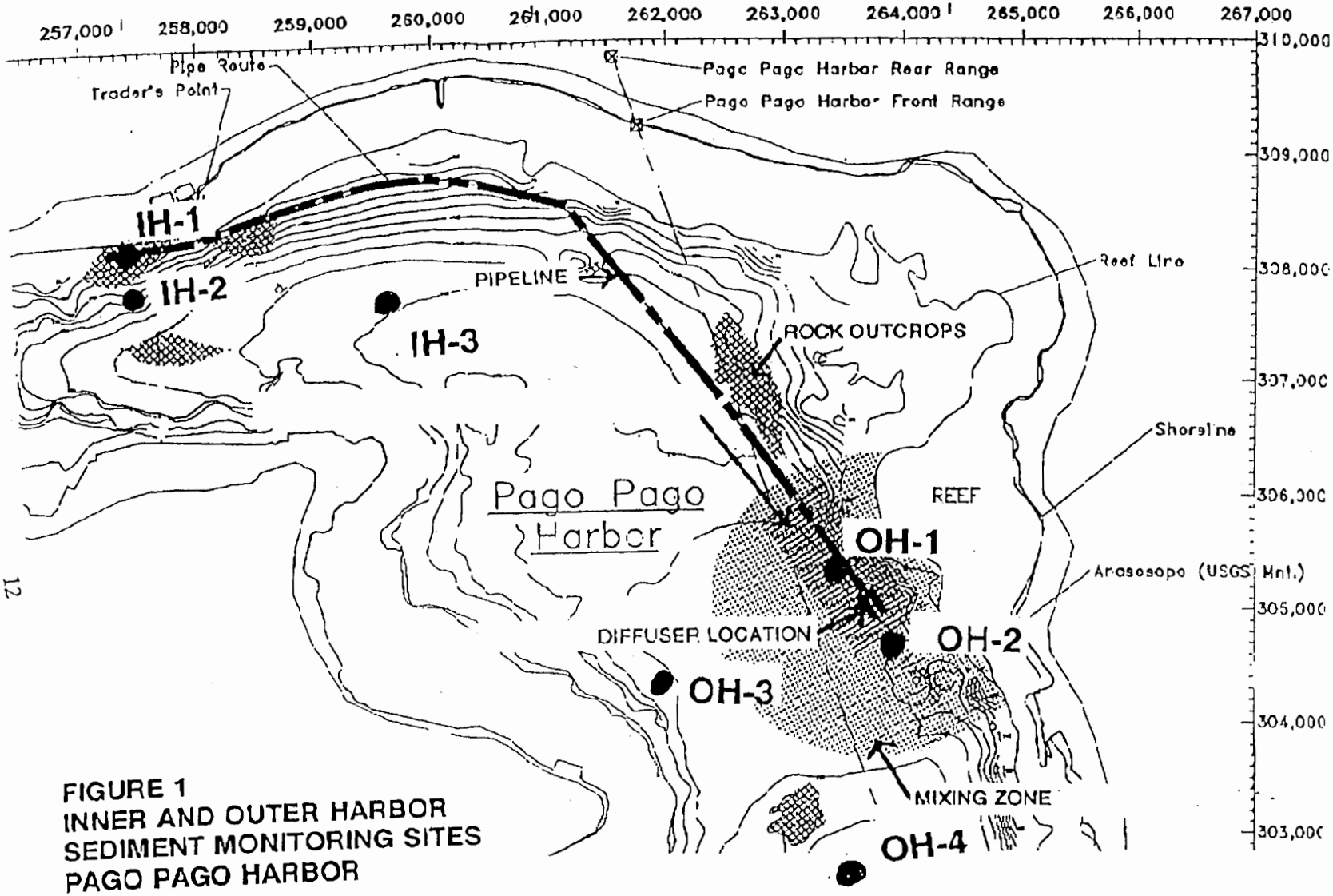


FIGURE 1
INNER AND OUTER HARBOR
SEDIMENT MONITORING SITES
PAGO PAGO HARBOR

AGENCY REVIEW DRAFT

JOINT CANNERY OUTFALL CORAL REEF SURVEY STUDY PLAN

for

StarKist Samoa, Inc.

and

VCS Samoa Packing Company

to comply with NPDES Permits

AS0000019

AS0000027

JANUARY 8, 1992

prepared by

CH2M HILL

AGENCY REVIEW DRAFT
January 8, 1993

JOINT CANNERY OUTFALL
CORAL REEF SURVEY STUDY PLAN

INTRODUCTION

This Coral Reef Survey Study Plan presents the plan for conducting field surveys of the existing coral reefs around Pago Pago Harbor. This study plan is required under the conditions of the United States Environmental Protection Agency (EPA) NPDES Permit No. AS0000019 for Star-Kist Samoa Inc. and NPDES Permit No. AS0000027 for VCS Samoa Packing Company. This document describes the objectives, approach, field methods, and data analysis procedures for the coral reef surveys.

Section I of the Star-Kist Samoa and Samoa Packing NPDES permits states the following concerning the Coral Reef Surveys:

> *"Within six months of the effective date of this NPDES permit, the permittee, in cooperation with {Samoa Packing Co.; Star-Kist Samoa}, shall submit a field study design for approval by ASEPA and EPA Region 9 to assess the potential impacts of the discharge on the nearby coral reef. The study shall include coral reef transects which shall conform to locations found on Figure 4 in the USE ATTAINABILITY AND SITE-SPECIFIC CRITERIA ANALYSES: PAGO PAGO HARBOR, AMERICAN SAMOA, FINAL REPORT (CH2M HILL, March 15, 1991). The intent of this annual survey is to detect significant differences, if any, from the database information found in the above-cited document. Videos shall be submitted to both the USEPA and ASEPA. Guidance for designing such surveys is provided in the Design of 301(h) Monitoring Programs for Municipal Wastewater Discharges to Marine Waters November 1982, EPA #430/0-82-010 (pages 70-71). In addition, the discharger should consult Ecological Impacts of Sewage Discharges on Coral Reef Communities, September 1983, EPA #430/9-83-010, for further information. The study shall be conducted within one year of the effective date of this permit and every two years thereafter."*

This study plan is being submitted to EPA to comply with the NPDES permit condition of Section I, and to provide for approval of this plan.

APPROACH

The NPDES permit states that coral reef surveys shall be conducted at all of the same sites surveyed during the 1991 Use Attainability Analysis (CH2M HILL, 1991), to detect significant differences, if any, from the 1991 baseline reef survey data. The wastewater discharge locations

for the canneries and receiving water conditions in the harbor have changed since the 1991 survey. In 1991, when the previous reef survey was conducted, the two canneries operated separate wastewater outfalls in the inner harbor area of Pago Pago Harbor. The 1991 surveys involved recording reef transects at multiple-depths along the reef fronts at 19 sites located around the entire circumference of Pago Pago Harbor. These 1991 coral reef field surveys were designed to provide comparable records of the reef conditions around the entire harbor for use in an evaluation of reef-face habitat conditions in areas of the inner, middle, and outer Pago Pago harbor. These surveys were designed to provide a semi-quantitative summary of reef corals and other benthic species, and reef fish identifications were incidental.

Presently, Star-Kist Samoa and Samoa Packing operate a joint wastewater outfall that extends over 7,000 feet west from the canneries to a deep-water site offshore of Anasosopo Point in the outer harbor. The outfall consists of a 16-inch HPDE pipe that terminates with a diffuser at a depth of 176 feet below MLLW. The diffuser is located north of To'asa Rock and approximately 500 feet west of the reef face near Anasosopo Point.

The approach and methodology for the coral reef survey has been designed to duplicate the 1991 reef video surveys that were conducted at each of the designated sites in Pago Pago Harbor, and to be consistent with available guidance provided in the Design of 301(h) Monitoring Programs for Municipal Wastewater Discharges to Marine Waters (USEPA, November, 1982). To meet the NPDES permit conditions, video transects will be recorded at multiple depths at each of the nineteen established reef transect sites around Pago Pago Harbor (Figure 1).

These coral reef field surveys will be conducted to provide video transect records of the reef conditions around Pago Pago Harbor that can be compared with the 1991 survey and with future surveys at the same locations. These surveys will be used to evaluate the condition of and changes to the reef-face habitat in areas of the inner, middle, and outer Pago Pago harbor. The surveys are limited to providing semi-quantitative data on the type, percent cover of live reef corals and other benthic species. Reef fish identifications will be incidental to the reef habitat evaluation. These video transect records will be analyzed and summarized by a qualified marine ecologist with knowledge of tropical reef taxonomy and several years of experience specifically in American Samoa. Estimates will be developed of live coral coverage and specific benthic genera identifications will be provided, as feasible from the video record. Field survey data will be presented in tabular formats in a coral reef survey report, and supporting data will be included in the report appendix. Copies of the video records will be provided to ASEPA and USEPA along with a report of the survey findings.

The first coral reef survey is presently scheduled for the first week of February 1993, after study plan approval by EPA. Subsequent surveys would take place in February 1995 and 1997.

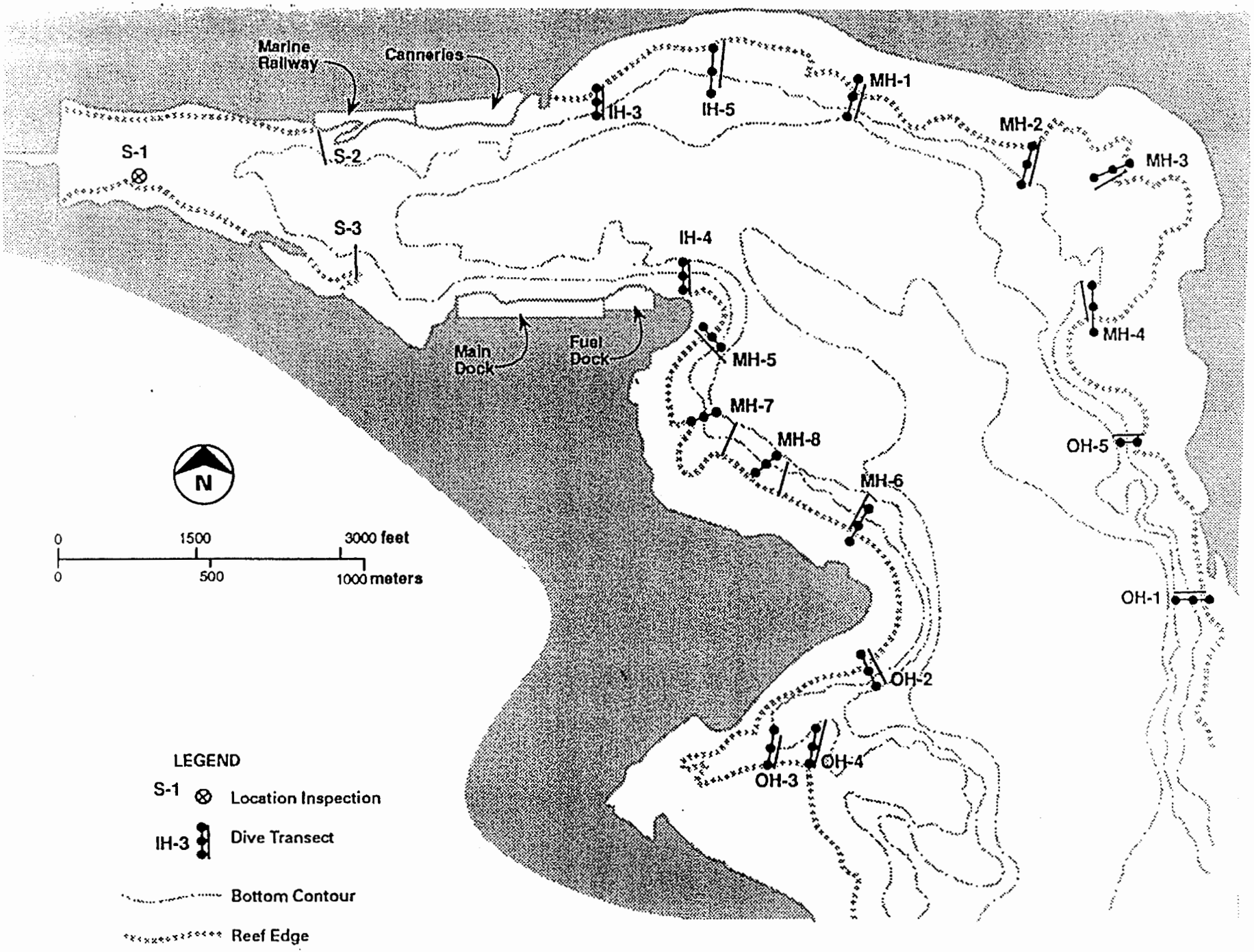


Figure 1

Coral Reef Transects in Pago Pago Harbor

AGENCY REVIEW DRAFT
January 8, 1993

STUDY METHODS

FIELD SURVEY METHODS

The following section describes the methods and equipment to be used for the coral reef surveys, including horizontal positioning at each reef site, sampling methods, and QA/QC procedures.

Field Equipment and Sampling Vessel

Field equipment requirements for the reef surveys are listed below in Table 1. A small work vessel will be used for the surveys. A three-person staff will be aboard to conduct the reef survey transects.

Table 1
Field Equipment for Coral Reef Surveys

Equipment Item	Purpose	Number of Units
Work Vessel	Field Sampling Platform	1
SCUBA diving equipment and tanks	Underwater surveys	3
ScubaPro Monitor II Dive Computer	Continuous dive logging for each diver's repetitive dives and surface intervals (safety equipment)	2
Sony 8mm Videocamera w/ underwater housing and lights	Underwater videotaping of reef transects	2
Sony 8mm Videotape player	Viewing and verification of videotape records	
Nikonos Camera	Underwater still photographs	1
30-meter transect line	Provide reference line for video transects	2
Transect Stakes	Establish start and end point for each transect	100
SeaKing Recording Fathometer	Record reef profile at each site	1
Motorola Mini-Ranger III System	Microwave positioning System with 3 shore-based transponders	1

Survey Sites and Field Positioning

Nineteen reef sites will be surveyed, and transects will be conducted at multiple depths at 16 of these sites. The three sites located in the western end of the inner harbor (S-1, S-2, and S-3) will only have a single transect conducted from the top to the base of the reef. The nineteen reef survey sites (Figure 1) will be located based on the descriptions in the 1991 reef survey logbook and photographs of the reef and shoreline at each site. A marker buoy will be set to mark each site. During the first reef survey in 1993, the horizontal position of each site will be recorded using a Motorola Mini-Ranger III electronic positioning system. The Mini-Ranger III will provide positioning accuracy of approximately ± 2 meters, to document each site in the harbor. A bathymetric profile of the reef front will also be made using a recording fathometer to document each site.

At each of the nineteen sites, transect marker stakes will be driven into the reef at the start and end of each transect. These stakes are designed to provide a long-term reference point for each transect line along the reef-face. In 1995 and 1997, if the transect marker stakes cannot be located by visual positioning, then the Mini-Ranger coordinates will be used to locate a site and a buoy will be deployed for divers to search for the stakes.

Reef Transect Methods

Marine biologist-divers will record underwater video transects on the reef fronts at 19 sites in Pago Pago Harbor (Figure 1). At 16 sites (IH-3, 4, 5, MH-1 through 8, and OH-1 through 5), video transects will be recorded along the reef face at three depths. The three sites located in the western end of the inner harbor (S-1, S-2, and S-3) are remnants of reefs with less than 5 percent live coral, and these sites will only have a single transect recorded from the reef flat down to the base of the reef face. Each video transect will be conducted parallel with the reef face (along a depth contour), and along a 30-meter fixed transect line on the reef. The depths for recording the video transects will include; the reef edge (15-20 foot depth), on the reef face (at 30-40 feet depths), and near the base of the reef face (at 55-65 feet depth). The reef front at some sites (e.g. MH-3) does not extend below 45 feet, and only two transects will be conducted at similar sites. Only single continuous transects from the reef top to base, will be recorded at the three inner harbor sites (S-1, -2, and -3). Video records of the reef flat areas will also be recorded at six representative sites (IH-3, MH-3, MH-8, OH-3, and OH-5) to document reef flat conditions.

At each of the nineteen sites, two divers will descend to the three designated transect depths and hammer at 3-foot PVC marker stake into the reef to mark the transect start. These transect marker stakes are to be driven into the reef at the start and end of each transect line to provide a long-term reference point for each transect line along the reef-face. After each marker stake

has been established then the divers will be at the deepest transect and they will commence the transect surveys at that point. The second diver will payout the 30-meter transect line and hammer the end marker stake into the reef. The 30-meter transect line will have markings every 2.5 meters. The first diver will swim very slowly along the established 30-meter transect line with the video camera and record two passes on the line. The second diver will take still photographs at 5 meter intervals along the transect line using a 35mm camera. At the completion of the transect filming, the transect line will be picked up and moved to the next transect depth and the procedure will be repeated.

A field logbook will be maintained to include; the sampling times, descriptions of the site, transect depths, reef face structure and features, reef biota observations, and weather and sea conditions. The videotape will be viewed at the completion of each day in the field to ensure that the record is complete and to record the location of each trasect record on the video tape.

QUALITY ASSURANCE AND QUALITY CONTROL

The quality assurance and quality control objectives for the coral reef surveys are to record representative reef-front transects at each site and provide scientific interpretations and summaries of these reef transect videos that are of known and acceptable quality. The following requirements will be followed to meet the objectives.

- Provide verifiable photographic interpretations of the reef transect videos with QA procedures to estimate accuracy and error. Ten percent of all video transects will be reanalyzed without identification to estimate accuracy and error.

- Establish long-term transect markers and document survey site positions (within 2 meters) for repeat surveys.

- Provide field equipment redundancy (backup equipment).

- Develop a field operations and safety plan for conducting the reef surveys to summarize the schedule, survey procedures, field data recording, and safety procedures. This operations and safety plan is a key element of quality assurance and control activities.

- Test all dive and photographic equipment onsite prior to the beginning of the surveys and conduct daily equipment checks.

DATA ANALYSIS AND PRESENTATION

These surveys will be used to evaluate the condition of and changes to the reef-face habitat in areas of the inner, middle, and outer Pago Pago harbor. These surveys will be limited to providing semi-quantitative data on the type, percent cover of live reef corals and other benthic species. Reef fish identifications will be incidental to the reef habitat evaluation.

The videotape transect records will be analyzed and summarized by a qualified marine ecologist with tropical reef knowledge and several years of experience specifically in American Samoa. The videotape analysis involves repeated slow-frame viewing of the transect video to record estimates of live coral coverage and specific benthic genera. The percent of live coral will be estimated at 5 meter intervals along the transect line, for 2.5 meter segments. The still photographs will provide a secondary source for verification of estimates. Benthic genera identifications will be provided, as feasible from the video record. Field survey data and site positioning data will be summarized in tabular formats in a coral reef survey report, and supporting data will be included in the report appendix. Copies of the video records will be provided to ASEPA and USEPA along with a report of the survey findings.

Copy to Doug Linden
Mike Lee

VAN CAMP
SEAFOOD
COMPANY, INC.

December 23, 1992

DEC 29 1992

Pat Young
U.S. EPA, Region 9
75 Hawthorne Street
San Francisco, CA 94105

Dear Pat:

Enclosed find a report entitled, "VCS Samoa Packing Company Wastewater System Evaluation Implementation Schedule," dated 12/21/92, which defines the status of recommendations from the "Wastewater Treatment System Evaluation" report prepared by CH2M Hill in June 1991.

This report fulfills the requirements of VCS Samoa Packing's NPDES Permit No. AS 0000027, Section K. Wastewater Treatment System Evaluation.

Sincerely,

James L. Cox

James L. Cox
Director of Engineering
and Environmental Affairs

JLC:ms

cc: Pati Fai'ai - ASEPA, Pago Pago, American Samoa
Mike Macready - Samoa Packing Company

Enclosure
122392.1JC

4510 Executive Drive, Suite 300 San Diego, CA 92121-3029
Phone: (619) 558-9662 FAX: (619) 597-4282

VCS SAMOA PACKING COMPANY

WASTEWATER SYSTEM EVALUATION

IMPLEMENTATION SCHEDULE

12 / 21 / 92

I. BACKGROUND

A REPORT ENTITLED "WASTEWATER TREATMENT SYSTEM EVALUATION" FOR THE VAN CAMP SEAFOOD SAMOA PACKING COMPANY WAS PREPARED BY CH2M HILL IN JUNE 1991.

SECTION III, ENTITLED "OPERATIONAL OBSERVATIONS AND RECOMMENDATIONS", ATTACHED, LISTS FIFTEEN (15) RECOMMENDATIONS TO IMPROVE WASTEWATER OPERATIONS.

Table 7
Recommended Wastewater Improvement

Item	Improvement	Priority
Laboratory Monitoring	Increase basic equipment inventory, add equipment to allow running greater numbers of samples, add jar and DAF test equipment, improve quality control system	A
Sampler and Flowmeter	Purchase refrigerated automatic sampler, install new flume flow recorder/totalizer	A
Surge Tank Level and pH Meter	Install level monitoring equipment to improve equalization, install pH meter to monitor need for adjustment to optimum pH for chemical coagulation	A
Pressure Tank Feed Pumps	Increase pumping capacity to maintain 65 psi pressure at design flow	A
DAF Float Trough Flush	Install flush system to minimize water use and prevent baffle overflow with solids	A
DAF Weir Leveling	Install adjustable weir plate to improve even distribution of surface overflow and prevent short circuiting	A
Viscera Grinder	Improve grinding capacity to prevent overflowing of solids to the wastewater system	A
Operator Training	Improve operator training to include chemical dosage checking, upgrade training in understanding of operational adjustments, work with plant personnel on in-house wastewater minimization	A
Coagulant Dosage	Improve coagulant dosage by increased jar and DAF testing	A
Hydraulic Loading	Improve in-plant water conservation to prevent further hydraulic overloading of the DAF	A
Polymer Feed Strength	Decrease polymer feed strength to meet manufacturer's recommendation	A
Sludge Tank Level	Install electronic level indicating device	B
Flocculation Tank	Increase floc tank size to accommodate 20-minute flocculation period, install separate rapid mix tank (1- to 3-minute detention time)	B
Equalization Control	Automate surge tank control system to optimize equalization and eliminate overflowing	B
Lime/Soda Ash	Continue testing under controlled conditions for definitive results	B

Notes:

A = First priority; improvement important to treatment system.
B = Second priority; improvement benefit-versus-cost unknown at this time; further investigation warranted.

II. IMPLEMENTATION / RESPONSE TO RECOMMENDATIONS

1. LABORATORY MONITORING

(a) Laboratory performance has improved by implementing procedures requiring quality checks using known control samples. Participation in USEPA Monitoring and Support Laboratory Water Pollution Performance Evaluation Testing has allowed the Sampac lab to increase accuracy.

(b) Additional equipment (i.e., 6 station Kjeldahl, large BOD incubator and waterbath) is being evaluated for purchase which will allow running a greater number of samples.

(c) Jar testing has been implemented using a newly purchased gang stirrer, to evaluate polymer dosage rates and performance.

2. SAMPLER AND FLOW METER

(a) As recommended, a Milltronics flow meter was installed on 11/15/92.

(b) Automatic sampler will be installed and operating by 4/30/93.

3. SURGE TANK LEVEL AND pH METERS

(a) Presently evaluating several level measuring equipment devices. A level measuring device will be purchased and installed by 6/1/93.

(b) PH meters are used on the surge tank and Parshall flume and final discharge sump. PH adjustment previously done in the flocculation tank is now done at the Parshall flume as recommended by the CH2M Hill report.

4. PRESSURE TANK FEED PUMPS

(a) Both pressure tank pumps rebuilt 9/1/92 to maintain a minimum of 65 p.s.i.

5. DAF FLOAT THROUGH FLUSH

(a) Installation of a flush piping system was completed 10/9/92 utilizing liquid from the high strength waste sump.

6. DAF WEIR LEVELING

(a) DAF weir leveling is scheduled for completion by 1/4/93. The need for an adjustable Weir is still being evaluated.

II. IMPLEMENTATION / RESPONSE TO RECOMMENDATIONS (Cont'd)

7. VISCERA GRINDING

(a) More frequent cutter bar knife replacement implemented.

(b) One (1) additional viscera pump ordered 11/27/92 to improve pump capacity.

(c) Existing 2" viscera line upgraded to 4". Completed on 12/13/92.

8. OPERATOR TRAINING

(a) All wastewater operators attended a one day training seminar in September. The main speaker was Bob Cunningham of Chemisis, Inc., a wastewater specialist. The talk was on wastewater chemical dosage and operation.

(b) Operators attended a video presentation on 11/27/92 on chemical handling and safety.

9. COAGULANT DOSAGE

(a) Daily jar effluent testing implemented using newly purchased jar stirrer.

10. HYDRAULIC LOADING

(a) Retort equipment replacement in the last quarter of 1992 has reduced plant water consumption by 100,000 G.P.D.

(b) Utilization of retort cooling water on clean-up and meal plant process has further reduced the plants water usage.

(c) In-house water reduction measures have been implemented in all areas to reduce water usage.

11. POLYMER FEED STRENGTH

(a) Manufacturers recommendations are followed when setting polymer dosage rates.

12. SLUDGE TANK LEVEL

(a) The sludge tank level indication has not been a problem and therefore cannot be justified.

II. IMPLEMENTATION / RESPONSE TO RECOMMENDATIONS (Cont'd)

13. FLOCCULATION TANK

(a) A larger flocculation tank and rapid mix tank will be budgeted for FY '93/94.

14. EQUALIZATION CONTROL

(a) No decision has been made on the proposal to install a vari–speed pump or control valve after the surge tank because it is not the most practical technology for use at Sampac.

15. LIME / SODA ASH

(a) A series of tests were conducted by increasing the pH in a slip stream of effluent in an attempt to precipitate out phosporus and nitrogen.

(b) This testing was inconclusive and was discontinued.

(c) No further testing will be conducted.

Engineers
Planners
Economists
Scientists

May 27, 1993

PDX30702.TS

StarKist Samoa, Inc.
StarKist Seafood Company
180 E. Ocean Blvd.
Long Beach, CA 90802

Attention: Mr. Norman Wei

Dear Mr. Wei:

Subject: Wastewater Treatment System Evaluation

Enclosed are six copies of our final report on the wastewater treatment system for StarKist's American Samoa cannery.

The wastewater system is operating effectively producing excellent effluent quality. The treatment equipment is in good working condition and well maintained. Unit loadings on the dissolved air flotation unit loadings are lower than typical design values for both solids and hydraulic capacity. The unit loading for air to solids ratio could not be determined due to the lack of an air flow meter. An air flow meter is important for proper operations, which directly impacts performance.

Waste stream monitoring provided interesting insight into the strength of the three major wastewater sources, but revealed no apparent means for reduction. Dry clean-up and water conservation are routinely practiced and records show a significant reduction in waste load. It was observed that greater diligence in some dry clean-up practices may provide some additional improvement in waste reduction.

Coagulant testing by jar tests indicated that the current alum/polymer system provides good removals. The other coagulants tested, ferric chloride and polymer, showed variable results with ferric chloride performing satisfactory and polymer performing poorly. The jar test results indicate that the current alum dosage may be slightly lowered without significantly reducing treatment efficiency. Additional operator jar testing should be done to confirm this observation.

Corvallis Office
2300 N.W. Walnut Blvd., Corvallis, OR 97330
P.O. Box 428, Corvallis, OR 97339-0428
503.752.4271
FAX 503.752.0276

In the area of operations, routine jar testing should be practiced and standard operating procedures developed. Additional automation and alarms should be considered as potential system improvements.

If you need any further assistance, please call.

Sincerely,

CH2M HILL

Brad Bjerke
Project Engineer

bsb/StarKist Samoa
cc: Steve Costa/CH2M HILL/SFO

JUN 03 1993

Copy to Mike Oda

StarKist Seafood Company

Memorandum

DATE: 1 June, 1993

TO: Pat Young, US EPA
Sheila Wiegman, AS EPA

FROM: Norman Wei

SUBJECT: **Wastewater Treatment System Evaluation for StarKist Samoa, Inc.**

Pursuant to Section K of StarKist Samoa Inc.'s NPDES Permit AS0000019, please find enclosed a copy of wastewater treatment System Evaluation Report prepared by CH2M Hill - an independent environmental consulting firm retained by StarKist Samoa.

The findings of the report are self explanatory. As indicated in the consultant's May 27th cover letter to the report, the wastewater system is "operating effectively producing excellent effluent quality". However, there are areas for improvement and StarKist Samoa will be reviewing the report and submitting a schedule for implementing the recommended improvements to your agencies within sixty (60) days.

Please call me if you have questions on this report.

Enclosure - one copy of report

cc: M. Callaghan
B. Mills
Wm. Adams
R. Ward

Wastewater Treatment System Evaluation
for
StarKist Samoa, Inc.

Prepared by

CH2M HILL

May 1993

Contents

Tables

Introduction

The wastewater treatment system at StarKist Samoa, Inc., tuna cannery in American Samoa, was evaluated during an onsite visit from February 2-10, 1993. The wastewater system evaluation was completed in response to National Pollutant Discharge Elimination System (NPDES) permit requirements. The tasks addressed in this report include:

- Review of current operations and equipment for possible modifications to decrease pollutant loads
- Identification of wastewater characteristics from three major sources and examination of waste load reductions
- Review dissolved air flotation (DAF) systems controls and operating parameters
- Test the effectiveness of three coagulants by jar and pilot DAF testing
- Recommendation of treatment system improvements, ranked in order of importance along with an estimated cost of each improvement

This report is organized into four sections. Section 1 discusses the treatment unit sizes, and operating description. Section 2 discusses permit limits, treatment performance, unit loadings and process control. Section 3 discusses the results of major wastewater stream sampling program and jar/pilot DAF testing. Section 4 presents the operational observations and recommended improvements. The improvements are prioritized and cost estimated.

Section 1

Treatment Unit Sizes and Operating Description

Unit Sizes

The wastewater system at StarKist consists of physical-chemical treatment and includes the following components:

- Thaw water supply pumps (2)
- Boiler water blowdown pumps (2)
- Boiler water cooling tower
- Thaw water sump pumps (2)
- Precooker juice sump pump
- Fishmeal sump pumps (2)
- Fishmeal press liquor pump
- Packing room screw sump
- Meal plant shaker screen
- Main collection sump pumps (4)
- Rotary screens (2)
- Screenings wet well pumps (3)
- Surge tank: 45-foot-diameter x 30-foot-high, volume 300,000 gallons
- Thaw water tank: 20-foot-diameter x 36-foot-high, volume 80,000 gallons
- Thaw water pumps (2)
- Pressurization pumps (3)
- Retention tank: 6-foot-diameter x 14-foot-high
- Alum tanks (2): 3.5-foot-diameter x 4-foot-high, volume 275 gallons
- Polymer tank: 4.5-foot-diameter x 5-foot-high, volume 500 gallons
- Dissolved air flotation tank: 45-foot-diameter x 11-foot-high, volume 130,000 gallons
- Parshall flume: 9-inch throat width
- Effluent wet well: 10,000 gallons
- Effluent pumps (3)
- DAF grit pump
- Float sludge (DAF) day tank: 9-foot-diameter x 10-foot-high, volume 6,000 gallons
- Sludge transfer pumps (2)
- High strength waste storage tank: 30-foot-diameter x 40-foot-high, volume 200,000 gallons
- Boat sludge pumps (2)

A process flow diagram of the wastewater treatment system is attached in Appendix A.

Operating Description

StarKist Samoa separates its high-strength waste from the other process wastewater for ocean disposal. The high strength sources include the precooker juice, fishmeal press liquor, and packing room screw sump. Solids are removed from these high-strength waste streams using a shaker screen. The other major high-strength waste stream source is the dissolved air flotation sludge. The high-strength waste is barged to disposal once per day.

Major wastewater sources transferred for treatment include thawing water, butchering area washwater, dock area water, spray cooling water, and packing room cleanup water. With the exception of the thaw water, the main wastewater sump collects these cannery wastewater sources for pumping to the rotary screens. The screened wastewater is then pumped to the surge tank for flow equalization. Pressurization pumps transfer the wastewater to a retention tank where air is added, followed by coagulation chemical addition and DAF treatment. Coagulation chemicals used in the treatment are alum and polymer. The alum is injected into the DAF inlet pipe several feet from the tank wall with the anionic polymer added 1 foot downstream of the alum. A strip chart recorder records the pH level continuously. Occasionally, pH correction with caustic is required before discharge. The treated wastewater flow is measured by a Parshall flume prior to pumped discharge into the combined cannery outfall.

Salt water pumped from Pago Pago Harbor is the primary thaw water source. Freshwater is occasionally used in lieu of salt water for select packs. The thaw water is collected in a sump separate from other process wastewater and pumped to a thaw water storage tank. The thaw water is then transferred to the process water surge tank during periods of low flow. The separate storage of thaw water allows more manual equalization of flow and temperature in the surge tank.

Section 2

Current Treatment Limits, Performance, Unit Loadings, and Control Description

Treatment Limits

The StarKist Samoa treatment system is currently handling wastewater flow of approximately 1.0 millon gallons per day (mgd) from tuna processing. The current discharge limitations are shown in Table 1.

Table 1
Effluent NPDES Limits

Parameter	Monthly Average	Daily Maximum
Total Suspended Solids (TSS) (lbs/day)	2,653	6,673
Oil & Grease (O&G) (lbs/day)	675	1,688
Total Phosphorus (TP) (lbs/day)	192	309
Total Nitrogen (TN) (lbs/day)	1,200	2,100
Total Ammonia (lbs/day)	---	133
Temperature (F)	90	95
pH	---	6.5-8.6

Treatment Performance

Current operations fully meet all of the limits listed in Table 1. The average effluent values from 1992 were 862, 210, 55, 922 lbs/day for TSS, O&G, TP, and TN, respectively. These values are about 70 percent lower than the permit limits for TSS, O&G and TP; and 20 percent lower than the permit limit for TN. Influent monitoring was discontinued in 1992, but based on 1991 data, removal efficiencies for the treatment plant averaged about 90 percent for total suspended solids (TSS), 90 percent for oil and grease (O&G), 65 percent for total phosphorus (TP), and 30 percent for total nitrogen (TN). The removal values indicate excellent historical treatment efficiency on parameters related to solids or precipitable compounds such as phosphorus.

Chemical dosages used in 1992 for alum and polymer indicate an average dosage of 92 mg/l and 2.5 mg/l, respectively. The polymer currently being used is a Nalco anionic

type. The polymer is fed as a 0.4 percent solution (2 gallons polymer per 500 gallons water).

Table 2 presents the monthly average effluent concentration values for the current treatment system from 1992 to present.

Table 2
Average Monthly Effluent Values for
January 1992 to February 1993

Date	Flow/2,000 lbs Fish	Alum Dosage (mg/l)	Polymer Dosage (mg/l)	TSS (mg/l)	Oil and Grease (mg/l)	TP (mg/l)	TN (mg/l)
1/92	2,470	83	1.75	74.6	19.8	4.5	88.5
2/92	2,530	85	1.66	103.4	24.5	6.1	103.4
3/92	2,820	90	1.85	80.0	20.2	5.8	130.3
4/92	2,620	91	1.85	177.0	40.4	13.5	118.6
5/92	2,230	90	1.92	74.6	11.2	4.7	93.7
6/92	2,520	94	1.96	64.9	13.2	3.9	92.9
7/92	2,330	95	2.09	56.6	17.4	3.5	68.8
8/92	2,520	97	2.52	95.7	28.8	3.9	79.8
9/92	1,970	101	2.71	62.9	11.8	3.7	70.8
10/92	2,110	94	2.64	52.0	20.2	4.3	67.4
11/92	1,700	92	2.57	59.5	12.9	4.6	53.5
12/92	1,680	94	6.39	62.1	15.6	4.5	67.2
1/93	1,880	95	2.67	65.3	19.9	3.5	63.2
2/93	1,9[illegible]	93	2.63	53.2	15.4	4.7	45.1
Min	1,680	83	1.6[illegible]	52	[illegible].2	3.5	45.1
Max	2,820	101	6.[illegible]9	177	40.4	13.5	130.3
Avg	2,240	92	2.5	77	19	5	82

As can be seen in Table 2, the influent flow per ton fish processed has steadily decreased due to expanded water conservation efforts. The average flow per ton fish averaged 2,800 gallons per ton fish in 1991 and averaged 2,240 since January 1992. The result is less total daily flow through the treatment system.

Unit Loadings

Table 3 shows the design parameters commonly used for DAF treatment systems. The table compares typical design values with average and maximum operating values observed at StarKist Samoa.

Table 3 DAF Unit Loadings			
Parameter	**Typical Design Range**	**Starkist Average Operating Value**	**Starkist Maximum Operating Value**
Operating Pressure (psi)	50 - 65	50 (1 pump) 60 (2 pumps)	60
Air/Solids Ratio (lbs of air/lbs of solids)	0.01-0.03	---	---
Solids Loading * ($lbs/ft^2/hr$)	2-4	0.2	0.7
Hydraulic Loading (gpm/ft^2)	0.5-1.5	0.6 (one pump running)	0.9 (two pumps running)
*Solids Loading based on influent total suspended solids samples from 1/91 through 2/92.			

The DAF operating values for StarKist's Samoa treatment system are well within normal design operating values. The air to solids ratio could not be determined due to a lack of an air flow measuring device. The visual inspection of the wastewater entering the tank did indicate air flow which appeared adequate for treatment.

The amount of solids loaded into the cell is low in comparison with the typical design values. The solids loading values were based on 1991 and early 1992 data. Influent TSS measurements were discontinued in early 1992, therefore, data from the past year are not available. The influent TSS concentrations measured during onsite work are approximately the same as previously measured, yet influent flow has steadily decreased.
Therefore, low solids loading values, lower than found in Table 3, are probably in current use.

Hydraulically the DAF is loaded within an acceptable operating range. The rated hydraulic capacity of the DAF (according to StarKist literature) is 2,000 gpm or approximately 1.25 gpm/ft^2. The flow rate through the system varies based on the number of pressurization pumps used. One pump produces a flow rate of about 1,000 gpm at 50 psi and two pumps at a flow rate of about 1,400 gpm at 65 psi. The flow varies around these values depending on the level of wastewater in the surge tank. The system is shut off at the low surge tank level. The tank is allowed to refill before restarting the pressurization pumps.

Control

The operation of the DAF treatment system components is primarily a manual function. Level switches control pumping operations from the sumps. After leaving the screenings wet well, operation becomes manually controlled by the operator starting and stopping pumps observed based on surge tank level. Operators also observe the thaw tank level and transfer water to the surge tank when the surge tank level is low and when it is used to supplement weekend flow. Chemical feed rates are manually adjusted to achieve an average alum dosage of 90 to 100 mg/l and polymer dosage of 2.0 to 2.5 mg/l.

Section 3

Waste Stream Monitoring and Jar/Pilot DAF Testing

Waste Stream Monitoring

The streams evaluated were the spray-cooling thaw water, butchering area, and packing room washdown. The streams were analyzed for nitrogen, phosphorus, total suspended solids, and oil and grease. Sampling for these specific waste streams was conducted on February 9 and 10. Grab samples were taken hourly at each location and combined for analysis. Estimations of waste stream flow values were based on calculations or water meter readings. The goal of the monitoring system was to evaluate the waste constituents of the waste streams and determine whether any methods to reduce the amount could be deduced.

The thaw water was sampled hourly for 24 hours at the thaw water sump. The volume was estimated based on thaw water tank pump downs. The pump downs, along with the estimated in-flow during pumping, gave a thaw water flow of 210,000 gallons. A separate estimate of the thaw water volume was calculated based on the tons fish processed, tons fish per thaw cycle, and volume thaw water per cycle. Approximately 480 tons of fish were processed on February 8 and 9 with about 14 tons per thaw cycle and approximately 8,000 gallons per cycle. The calculated volume for the thaw water during the sampling period would be about 275,000 gallons. The error in the pump down estimation should be less than the rough calculation based on fish processed. Therefore, thaw water was estimated at 210,000 gallons.

The spray-cooling samples were grabbed hourly in a sump in the cooling area, which collected water from about one-third of the cooling area. Water flow data for the spray cooling could not be directly obtained. Several water meters in the area were monitored to develop a rough estimate of volume. The estimate was based on the packing room meter minus fishroom, fishmeal, and dock meter readings. Total dock flow (metered at only one of two lines to dock) was estimated at 60,000 gallons. The spray cooling flow value by this method still included the butchering area water flow. The water flow from butchering could not be estimated separately, but was estimated as contributing about 25 percent of the spray cooling flow. A butchering wastewater sample was collected hourly. The plant washdown wastewater was sampled during the night shift cleanup. The afternoon shift cleanup is primarily a dry clean with limited water usage. The high pressure water used during packing room cleanup has a separate meter, therefore the flow should be representative. The proportion of packing room cleanup water used during the night shift represented two-thirds of the high pressure water flow for the day.

Table 4 shows the results of the waste stream analysis and flow monitoring.

Table 4 Select Waste Stream Monitoring						
Area	TSS (mg/l)	O&G (mg/l)	TP (mg/l)	TN (mg/l)	NH3-N (mg/l)	Flow (gal)
Spray Cooling	650	329	242	1,204	465	51,000
Thaw Water	105	9.1	28	59	34	210,000
Butcher Area	435	170	97	207	101	17,000
Packing Room	9,025	308	214	722	52	56,000

Several comparative observations can be made from the results.

- Spray cooling wastewater is high in TP, O&G, TN and NH3-N, contributing over one-third of the TP and O&G, one-half of the TN, and two-thirds of the NH3-N mass from the four streams.

- Thaw water contributes a majority of the flow. Even so, only one-fifth of the total mass of TP and NH3-N is contributed by the thaw water.

- Butcher area wastewater contributes a relatively small portion of the total load, due to the low flow.

- Packing room wastewater contributes about 90 percent of the TSS load, and over one-third of the O&G, TP and TN load.

Spray cooling contributes a majority of the waste load in terms of O&G, TP, TN, and NH3-N but offers no apparent means for reduction. The current system uses a mist spray to minimize water flow, yet achieve the cooling function.

Thaw water, though contributing a majority of the flow, does not make a large contribution to the total load from the four major waste streams. The recycle of thaw water would reduce hydraulic load, but waste concentrations would likely increase. Therefore, no net reduction in load would be seen by recycling thaw water.

In-plant water conservation was apparent in all areas of the cannery. The packing room cleaning operation used dry cleanup prior to wet cleanup to minimize waste load to the treatment system and maximize the fish meal product. The waste stream sampling program illustrates the major TSS waste load contributed by the packing room. Even though cleanup

activities in the packing room are good in terms of dry cleaning procedures, continued efforts at waste minimization in the packing room area should be made. The packing room cleanup was observed to still have potential for additional capture of solids before wet cleaning, such as not sweeping scraps over wastewater channels with grating.

The daily monitoring of in-plant water usage at various locations provides useful data in specific plant area water minimization. The only area of potential water conservation improvement would be in the dock water usage. Continuously running, unattended hoses could often be seen. The waste load would not be decreased significantly by conserving water in this area, but a decrease in the hydraulic load to the treatment system could be realized. Improvements in water conservation not only reduces the treatment system hydraulic load but reduces the cannery's treated water demand.

Unfortunately, a misunderstanding with operations staff resulted in no influent composite sample. Therefore, the proportion each individual waste stream strength contributed to the total wastewater strength is unknown. Influent mass data from 1991 was used for general comparison purposes, although, the 1991 values are higher than present loads probably due to waste minimization efforts enacted since then. The 1991 average influent load was 6,420 lbs/day TSS, 2,920 lbs/day O&G, 250 lbs/day TP, and 1,540 lbs/day TN. The four waste streams which were monitored had total loads of 4,740 lbs/day TSS, 320 lbs/day O&G, 260 lbs/day TP, 980 lbs/day TN, and 300 lbs/day NH3-N. The additive results from the four waste streams indicate they would contribute 74 percent of the TSS load, 11 percent of the O&G load, 96 percent of the TP load, and 64 percent of the TN load, if compared to 1991 influent waste.

Jar/Pilot DAF Testing

A four-place jar stirrer and a bench scale DAF unit were used in coagulation chemical testing. Twenty-four hour composite influent samples were collected on February 4-5, February 5-6, and February 8-9, 1993. The untreated influent was analyzed for pH, turbidity, TSS, O&G, TP, and TN. The influent samples were tested using three chemical programs: alum, ferric chloride and polymer.

The method and procedures for the jar testing routine were as follows:

- A four-station gang stirrer equipped with variable-speed drive and a separate lighted stage mixed the one liter samples.
- Mixer speeds were standardized using a 1 minute rapid mix of the primary coagulant. If a bridging polymer was used, a 30-second rapid mix followed the primary coagulant.
- A 3-minute slow mix flocculation step preceded a 10-minute quiescent period.

In general, the pH was not adjusted prior to application of the treatment mode. Samples were withdrawn from the jar using a pipet. The samples were analyzed for pH, turbidity, TSS, O&G, TP, and TN. Turbidity and pH were measured immediately after jar testing. The results from the turbidity meter may not be accurate due to calibration outside the measured range (the only standard available was 0.1 NTU) but were reproducible so comparative use of the data should be valid. All other analyses were conducted in-house by StarKist laboratory staff.

The pilot DAF consisted of a Float-Treat Test Kit. A sample was treated using the jar test procedure of chemical addition with rapid mix. The cell was filled three-fourths full with treated sample and pressurized with a hand pump to 50 psi. After 30 seconds of vigorous shaking, the liquid was released to a 1 liter jar. Samples were withdrawn from the jar after 10 minutes.

The pilot DAF system as described did not produce a floatable floc when tested with the alum and polymer program. The floc appeared to be broken up by the procedure. In addition, the lack of a continuously pressurized release of wastewater compounded the failure. Full-scale treatment indicates that a floatable floc can be formed with the alum/polymer program. Therefore, to avoid a skewed comparison of different chemicals, the pilot DAF system testing was discontinued. The test did illustrate the fragile nature of the alum/polymer floc and suggests the chemical application point should remain near the DAF inlet to minimize floc disruption.

The treatment goal, to meet permit limits, requires the system to produce an effluent with average concentrations less than 318 mg/l for TSS, 81 mg/l for O&G, 23 mg/l for TP, and 144 mg/l for TN. The concentrations are based on an average flow of 1.0 mgd. The jar test results were evaluated with these concentration limits representing maximum values. The jar test goal was to produce the lowest reasonable concentrations.

Jar Test Results for Alum Treatment

A grab sample was collected on February 4, 1993, for the initial screening jar testing. The results for alum and polymer are shown in Table 5.

Table 5 Alum/Polymer Jar Test Screening Results				
Alum (mg/l)	**Polymer (mg/l)**	**pH (units)**	**Turbidity (NTU)**	**TSS (mg/l)**
0	0	6.4	---	516
25	1.5	6.5	4.5	47
50	1.5	6.4	4.3	26
75	1.5	6.3	2.6	39
125	0.5	6.4	1.1	23
250	1.0	6.1	1.0	18
370	1.5	---	2.5	---
625	2.0	---	4.4	---

The screening test results indicated alum dosages less than 100 mg/l provided 90 to 95 percent TSS removal with little added TSS removal efficiency at higher dosages. The remainder of the alum testing was done with dosages lower than 100 mg/l.

Table 6 shows the results of alum and polymer treatment jar testing on a composited sample collected on February 4 and 5, for removal of TSS and O&G.

Table 6 Alum/Polymer Jar Test Results					
Alum (mg/l)	**Polymer (mg/l)**	**pH (units)**	**Turbidity (NTU)**	**TSS (mg/l)**	**O&G (mg/l)**
0	0	6.2	65	1,127	493
50	2.5	6.1	2.1	65	8.3
65	2.5	6.1	2.3	72	15.1
80	2.5	6.2	3.4	58	14.4
95	2.5	6.0	2.3	52	5.9

The results indicated that the pH was reduced less than 0.2 pH units for all alum dosages. The results of testing for O&G removal using alum and polymer show excellent removal,

greater than 97 percent, at the four dosages tested. The results obtained for both O&G and TSS also indicate little added removal with dosages greater than 50 mg/l.

Test results for removal of TSS, TP, and TN using alum and polymer were obtained on a composite sample collected on February 8 and 9. The results are shown in Table 7.

Table 7
Alum/Polymer Jar Test Results

Alum (mg/l)	Polymer (mg/l)	Turbidity (NTU)	TSS (mg/l)	TP	TN
0	0	75	855	14.8	112.1
35	2.5	17	149	13.1	82.6
50	2.5	11	136	7.2	64.4
65	2.5	8	79	8.6	75.6

Table 7 shows the removal of TP improves substantially between the 35 and 50 mg/l alum dosages with approximately a 50 percent removal. The removal of TN shows the 50 mg/l dosage provided the best removal of the three dosages tested with approximately a 40 percent removal. The removal of TSS was best at the 65 mg/l dosage. The results for the 65 mg/l were similar to full scale results with 90 to 95 mg/l dosages.

Alum and polymer treatment with pH adjustment to pH 7 and 7.5 indicated little change in respect to turbidity and TSS, but showed much lower TP removal, less than 20 percent. The literature supports this observation with minimum solubility of aluminum phosphate at pH 6 and the optimum pH range between 5.5 and 6.5.

Jar Test Results for Ferric Chloride and Polymer Treatments

Ferric chloride was tested using the February 8 and 9 composite sample. The three dosages tested are shown in Table 8.

Table 8 Ferric Chloride Jar Testing Results					
Ferric Chloride (mg/l)	**Polymer (mg/l)**	**Turbidity (NTU)**	**TSS (mg/l)**	**TP (mg/l)**	**TN (mg/l)**
0	0	75	855	14.8	112.1
50	0	10	105	7.7	75.7
75	0	6	48	5.6	79.8
100	0	8	64	5.7	75.6

Ferric chloride produced treatment results similar in magnitude to alum treatment. The use of an appropriate polymer would probably increase the effectiveness. Due to the large number of polymers available, testing with various types was not done. Ferric chloride typically has a higher cost than alum yet has similar treatment results. Additional jar testing by StarKist would be needed to fully determine whether the benefits outweigh the costs. The sampling procedure collected insufficient sample volume for oil and grease analyses.

A limited number of samples were analyzed for a treatment mode based strictly on polymers. A polymer sales representative performed initial screening tests on a grab sample taken on January 26, 1993, and provided recommendations for additional jar testing. Vendor and on-site results, with and without pH adjustment, for a cationic polymer and a cationic with anionic polymer are shown below in Table 9. The results of the tests preformed by the Vendor and results of analyses on composite samples taken during the onsite study are combined in Table 9.

Table 9 Polymer Jar Test Results								
Date	Cation (mg/l)	Anion (mg/l)	pH (units)	Turb. (NTU)	TSS (mg/l)	O&G (mg/l)	TP (mg/l)	TN (mg/l)
1-26	0	0	6.5	---	598	1,069	7.2	166.1 (TKN)
1-26	8	0	6.5	---	120	103	0.3	51.3 (TKN)
1-26	8	2	8.5	---	96	126	4.5	44.8 (TKN)
2-5	0	0	6.2	65	1127	---	---	---
2-5	8	0	6.2	17	162	---	---	---
2-5	8	2	6.2	16	237	---	---	---
2-9	0	0	6.6	75	855	382.9	14.8	112.1
2-9	8	2	6.6	18	196	2.2	14	54.6
2-9	6	1	6.6	25	183	---	21.2	56.1

The polymer treatment mode did not provide effluent quality similar to alum. In general, all treated samples had considerable haze, which is evident in the turbidity values. The polymer treatment program did not remove the TSS, O&G, or TP as well as alum. Based on the apparent decrease in overall treatment, a polymer only treatment mode is not recommended.

Jar Test Discussion

The jar test results indicate that the current alum and polymer program provides removal efficiencies that far exceed the required treatment. The jar test results are further confirmed by full-scale results of the same magnitude. It appears that satisfactory results are obtained at dosages of 50 to 65 mg/l alum and 2.5 mg/l polymer. The treatment efficiency does increase at higher alum dosages, but only slightly. A balance between the additional treatment achieved and the increased sludge disposal required should be evaluated by StarKist. Current full-scale application rates are approximately 100 mg/l alum and 2.5 mg/l polymer.

Section 4

Operational Observations and Recommended Improvements

Operational Observations

The operation of the treatment system is a manual operation and is highly dependent on the proficiency of the operator. Day shift operations are excellent with lead operator supervision over operations tasks. The operations attention appeared to decrease in evening and night shifts. It was observed during an evening shift that no air was being supplied to the DAF. Once alerted to the problem, the operator bled water from the air line and restored proper operation. Currently, the operator must inspect the DAF surface for indication of air. It is important to add an air line rotameter for monitoring of the air flow to the DAF. Occasional influent TSS samples will also be required to verify the proper air to solids ratio.

Automation of the treatment system is an available option to continuous manual control. Level monitoring systems in the surge tank and thaw tank could be used to start and stop pumps, as well as indicate alarm conditions. The maintainability of an automated system in Pago Pago is a major concern and may make this option undesirable. Automation does eliminate treatment inefficiencies associated with manual operation, but also could contribute to inefficiencies if not reliable.

The chemical dosage was determined based on the visual observation of the effluent. The wastewater does change based on the size of fish being packed and the type of pack (certain packs require a freshwater thaw). Jar testing should be implemented to verify proper dosages. The frequency of jar testing should be, as a minimum, weekly and preferably daily. The added jar testing should not require more than 1 hour of operator time and could use turbidity as an indicator of effluent quality. The results of the onsite jar testing indicated the currently used alum dosage is more than adequate and may be slightly higher than required. Routine jar testing by the operations staff would help in refining the alum dosage. The two other chemical coagulants tested, ferric chloride and polymer, did not appear to provide any distinct treatment advantage over alum.

The operator log sheet for each shift and the startup procedure are attached in Appendix B. Hourly inspection of tank levels, pump operation, flow, and pH are required by the operator. The startup procedure description is not a routinely used reference. Valves are not numbered and pumps are not numbered as written. Simple instructions should be prepared, which reflect the Samoa wastewater system operation. The instructions should describe the operating strategy concerning pressurization pump operation in conjunction with surge tank level, thaw tank water transfer to surge tank, spot check procedures on effluent quality, and calibration of instruments such as the flume and pH meter.

During a night shift, two overflow events were witnessed. Both the thaw sump and screening sump were seen overflowing. Neither overflow resulted in discharge to the harbor but caused considerable back up in the dock area. The screening sump overflow was caused by a sticking float switch and the thaw water sump was caused by a motor trip out. Alarms to alert operators of these overflows do not exist. Only one alarm exists, a red beacon for a high level in the effluent pump station sump. The revolving red beacon alarm light is located next to the effluent sump. The logistics of providing additional alarms is not known, although it would be desirable to have a central alarm panel with signals from currently unmonitored components wired to the beacon for a common alarm light.

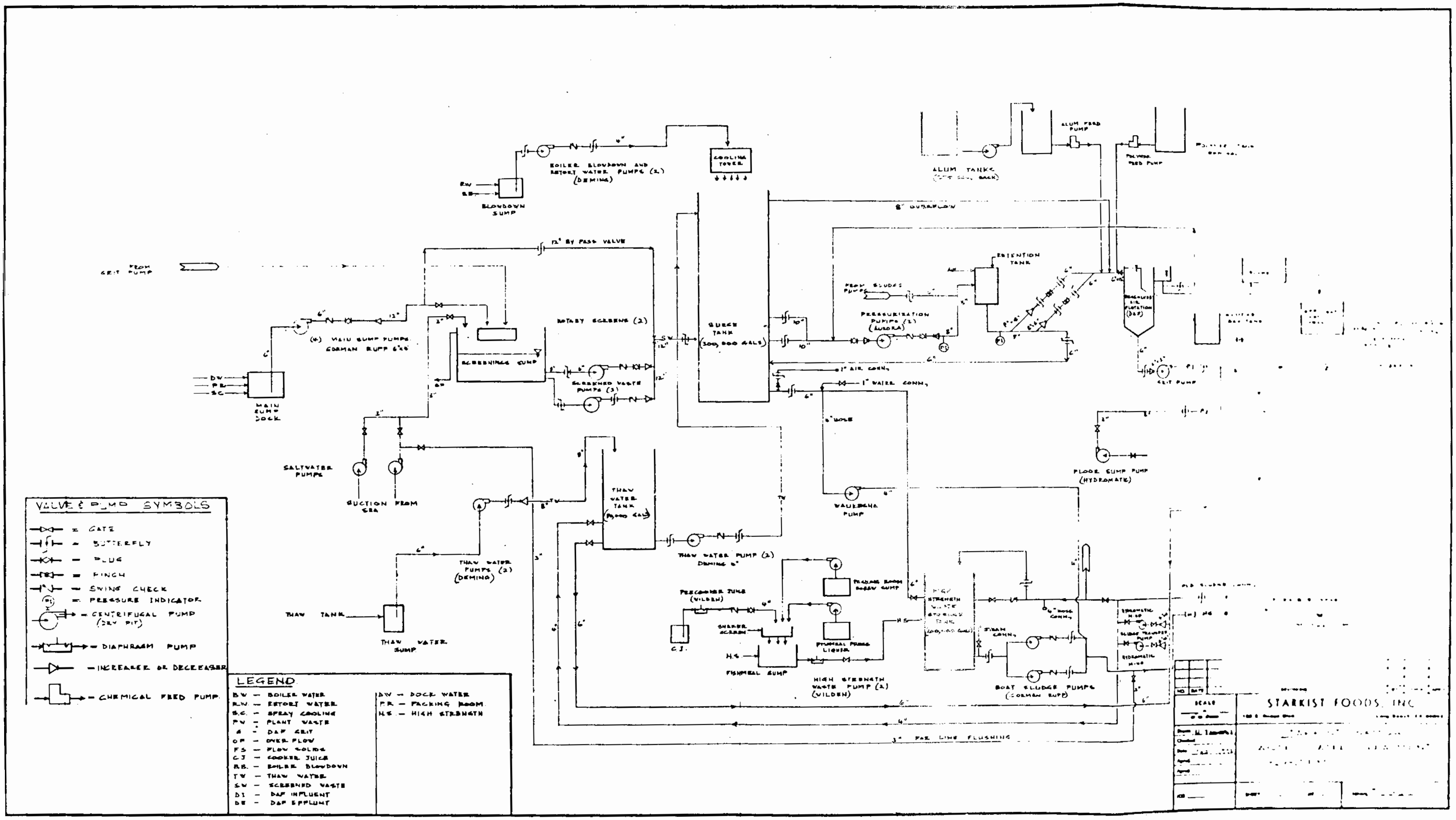
Recommended Treatment System Improvements

System improvements for the StarKist Samoa cannery include both equipment and operations. The recommended improvements are tabulated and ranked in terms of importance to the efficient operation of the treatment system. Table 10 lists the recommended improvements, estimated cost (if any), and the priority of each item. Level A priorities are important to improvement of the treatment process. Level B priorities have unknown treatment improvement benefits and further evaluation may be warranted.

Table 10
Recommended Wastewater Improvements

Item	Improvement	Priority
Air Flow Measurement	Insert air flow measuring device in compressed air supply to retention tank for operator control and monitoring. Estimated cost $500.	A
Coagulant Dosage	Improve coagulant dosage monitoring by increased jar testing.	A
Operation Procedures	Prepare operations procedures for treatment system.	A
Alarm System	Install high level sump alarms to minimize overflows. Estimated cost $5,000.	B

Appendix A
Wastewater Process Flow Diagram


VALVE & PUMP SYMBOLS
= GATE
= BUTTERFLY
= PLUG
= PINCH
= SWING CHECK
= PRESSURE INDICATOR
= CENTRIFUGAL PUMP (DRY PIT)
= DIAPHRAGM PUMP
= INCREASER OR DECREASER
= CHEMICAL FEED PUMP
LEGEND
B.W. — BOILER WATER
R.W. — RETORT WATER
S.C. — SPRAY COOLING
P.W. — PLANT WASTE
— DAF GRIT
OF — OVER FLOW
FS — FLOW SOLIDS
CJ — COOKER JUICE
B.B. — BOILER BLOWDOWN
TW — THAW WATER
SW — SCREENED WASTE
DI — DAF INFLUENT
DE — DAF EFFLUENT
DW — DOCK WATER
P.R. — PACKING ROOM
H.S. — HIGH STRENGTH
BOILER BLOWDOWN AND RETORT WATER PUMPS (2) (DEMING)
BLOWDOWN SUMP
COOLING TOWER
12" BY PASS VALVE
FROM GRIT PUMP
(4) MAIN SUMP PUMPS GORMAN RUPP 6"x6"
ROTARY SCREENS (2)
SCREENINGS SUMP
SCREENED WASTE PUMPS (3)
MAIN SUMP DOCK
SALTWATER PUMPS
SUCTION FROM SEA
SURGE TANK (300,000 GALS)
8" OVERFLOW
1" AIR CONN.
1" WATER CONN.
6" HOSE
WAUKESHA PUMP
ALUM TANKS
ALUM FEED PUMP
POLYMER FEED PUMP
RETENTION TANK
FROM SLUDGE PUMPS
PRESSURIZATION PUMPS (2) (AURORA)
GRIT PUMP
FLOOR SUMP PUMP (HYDROMATE)
THAW WATER TANK
THAW WATER PUMPS (2) (DEMING)
THAW WATER PUMP (2) DEMING 6"
THAW TANK
THAW WATER SUMP
PRECOOKER JUICE (WILDEN)
SHAKER SCREEN
FISHMEAL SUMP
FISHMEAL PRESS LIQUOR
PACKING ROOM
HIGH STRENGTH WASTE PUMP (2) (WILDEN)
HIGH STRENGTH WASTE STORAGE TANK
STEAM CONN.
BOAT SLUDGE PUMPS (GORMAN RUPP)
SLUDGE TRANSFER PUMP
3" FAR LINE FLUSHING
SCALE
STARKIST FOODS, INC

Appendix B

Treatment System Daily Log Sheet and Startup Procedure

STAR-KIST SAMOA, INC.- WASTE WATER TREATMENT LOG

DATE	LEVEL	SETTING	PARSHALL	PH	WATER	FLOW	BEFORE ROTATION	LEVEL	[illegible]	LEVEL	SETTING	SUMP	PROCESS	AIR	DOCK AREA
HOUR	ALUM TANK	ALUM PUMP	FLOW	READ.	TEMP.	LEVEL	PRESSURE	SURGE	PRES[illegible]	POLY. TANK	POLY PUMP	PUMP	PUMPS	PRESS	

[illegible]

START-UP PROCEDURE

FOR

2000 GPM FLOTATION CELL

STAR-KIST SAMOA, INC.

NORMAL START-UP PROCEDURE

1. Open valves at transfer pump.

2. Open valve #1 at surge tank.

2.5 Start Compressor #1.

3. Start transfer pump.

   a) Be sure it is primed.

3.5 Open valve #4 from surge tank.

4. Open valve #3 or valve #2 depending on whether you use pump #6 or pump #7.

5. Open valve #6 or valve #7 depending on whether you use pump #6 or pump #7.

6. Valve #11 will open automatically when either pump #6 or pump #7 is started.

7. Start pump #6 or pump #7 depending on which suction and discharge valves you open inoperation #4 and #5 above.

8. Adjust pressure at valve #11 so pressure gauge reads 55 psi.

9. When the flotation cell is full and water is coming out of the riser tubes then turn on motor #4. This is the top sludge scraper drive.

10. Level in the flotation cell may be adjusted by adding rings to the tubes or taking them out. The water level should be 1/2 way up the sludge ramp.

11. If the level in the surge tank is low then water will return to the tank by gravity through the recycle valve #15. This valve is controlled by the liquid level controller A. When the output signal reads zero then the valve is open. When the output signal reads 25-30 then it is closed.

12. When the level in the surge tank rises, the float in the liquid level controller will automatically close off the recycle valve. This action will force more water through the final discharge line.

13. The speed of motor #4 which is the sludge scraper arm motor may be changed to suit by merely turning the speed dial on the side of the unit. This dial should never be turned unless the motor is running. Normal speed should be close to zero on the dial. Too much speed of the arm will remove excess water with the top sludge.

14. The sludge tank receives the material which the top scraper pushes over the ramp. This material will dewater on standing and can be decanted by opening valve #17 and valve #16. When these valves are opened and the pump #3 is started then bottom water from the sludge tank will be removed and pumped to the top of the flotation cell. This discharge should be observed and when the water turns to sludge then pump #3 should be turned off. At this point close valve #17 and open valve #19. When the pump is started again it will transfer the sludge to

a tank wagon. When the level in the sludge tank gets near the bottom turn off pump #3 and shut all valves.

15. In the event that the quality of water is not clear enough it is an indication that chemical is needed. The alum pump is pump #2 and has a valve in the discharge line. Open this valve and turn on pump #2. This pump has two pumping heads and each head has an adjustable stroke. Probably one head only will be used and the other head should be set to zero feed.

16. Alum should be mixed in the white plastic tank at a concentration of 1 pound of alum to one gallon of water. The alum should not be dumped into the tank by the bag full. Rather, take smaller quantities and spread it over the surface of the water. From time to time, turn on the air line to mix up the entire solution. Do not let the air line stay on except for short periods of time.

PROCEDURE TO REMOVE BOTTOM SLUDGE FROM FLOTATION CELL

1. Open valve #13.

2. Open valve #14.

3. Turn on pump #5.

4. Observe water being discharged to the sludge tank. When it runs clear shut-off pump #5. Close Valves #13 and #14.

PROCEDURE TO REMOVE BOTTOM SLUDGE FROM SURGE TANK BY PUMP #5

1. Open valve #12.

2. Open valve #14.

3. Turn on pump #5.

4. Observe water being discharged to the sludge tank. When it runs clear shut-off pump #5. Close valves #12 and #14.

PROCEDURE TO BACKWASH SANDPANS

1. Pump #6 or #7 must be running.

2. Open valve #9. Leave valve open for 10 minutes.

3. Build-up the pressure on valve #11 so it shuts off.

4. Close valve #9.

5. Reset pressure on valve #11 to hold 55 psi.

PROCEDURE TO REMOVE TOP SLUDGE FROM SURGE TANK

1. Open valve #5 when either pump #6 or pump #7 is in operation. Sludge will not be removed unless the level in the surge tank is down to the top of the hog trough.

2. Open valve #10 to jet water into the surge tank from either pump #6 or pump #7 or both.

3. Close valve #10 when top sludge is removed.

4. Close valve #5.

PROCEDURE TO REMOVE BOTTOM SLUDGE FROM SURGE TANK THROUGH THE SANDPANS
Pump #6 plus Pump #7

1. Pump #6 or pump #7 must be running.
2. Open valve #8.
3. Close valve #4.
4. Allow valve #8 to remain open 1/2 hour.
5. Shut valve #8.
6. Reopen valve #4.

CHEMICAL FEED

Polymer is mixed at a ratio of 5 pounds poly powder to 50 gallons water.

Each poly pump head will pump 5 gallons per hour maximum feed. Each head can be adjusted for 0-100 percent of feed rate.

To change feed rate, lift up the locking arm and change dial to desired percentage. Return lock arm to lock position.

AIR INJECTOR SYSTEM

Pumps # 6 and # 7 are equipped with an air injection system. This system has a valve on each side of the penberthy hydraulic ejector. Both valves should be open when the pump is running. The air rotameter should be set to read 5 CFM.

If the system plugs with debris then close the two valves and remove the pipe plug at the top of the tee. Take a wire rod and ram it down the plug hole till the debris is dislodged. Replace the plug. Open both valves again.

	Valve #	Type
Inlet to Surge Tank	1	12"-D
Suction to Pump #7	2	8"-D
Suction to Pump #6	3	8"-D
Suction Discharge from Surge Tank	4	10"-D
Discharge from Hog Trough	5	6"-D
Discharge from Pump #7	6	6"-D
Discharge from Pump #6	7	6"-D
Suction Valve from Sandpans	8	6"-D
Discharge to Sandpans for backwash from retention tank.	9	6"-D
Discharge to Surge Tank (Jet)	10	6"-D
Automatic Valve to Flotation Cell	11	-Saunder
Suction Line from Sandpans to Barnes Sludge Pump #5	12	6"-D
Suction Line from Flotation Cell to Barnes Sludge Pump #5	13	6"-D
Discharge from Barnes Pump	14	-Gate
Automatic Recycle	15	10"-D
Liquid Level Control	A	
Chemical Pump	P#2	
Sludge Pump - Prog. Cavity	P#3	
Discharge from Sludge Tank	16	3"-D
Discharge from Pump #3 to Flotation Cell	17	-Gate
Discharge from Pump #3 - Reduction	18	-Gate
Discharge from Pump #3 - Truck	19	-Gate
Skimmer Motor #4		
Compressor Motor #1		

StarKist Samoa, Inc.

A Subsidiary of Star-Kist Foods, Inc.

P.O. Box 368
Pago Pago, Tutuila Island
American Samoa 96799

Telephone: 684 644-4231
Facsimile: 684 644-2440

Rcd 10/22/93
Copy to Mike L. Robyn Stu
W.S-1

October 13, 1993

TO : Norman Lovelace, US EPA Region IX
Togipa Tausaga, ASG EPA

FROM : Maurice W. Callaghan

SUBJECT: POLLUTION PREVENTION PROGRAM

==========

Please find attached a copy of StarKist Samoa, Inc.'s Pollution Prevention Program in partial fulfillment of our NPDES requirements.

Please call me or Norman Wei if you have any questions.

/tl

cc: B. Mills
W. Adams
N. Wei
R. Ward

Pollution Prevention Program

Introduction

In 1992, StarKist Samoa Inc. initiated a comprehensive Pollution Prevention Program. This report is submitted in fulfillment of the requirements of the company's NPDES permit.

Source Reduction and Waste Minimization Programs

The following sections describe the various components of StarKist Samoa's source reduction and waste minimization programs.

Replacement of Existing Fishmeal Plant. A major component of the source reduction program is StarKist Samoa's plan for a new fishmeal plant. The plant has received corporate approval to replace the entire fishmeal plant at a cost in excess of $6.5 million. StarKist Samoa is now in the final stage of negotiation with the contractor to initiate construction of the plant. Projected installation time is estimated to be 15 months. The new fishmeal plant will include a centrifuge and a multi-stage distillation unit which would recover oil and protein from the cooker juice and press liquor - the two high strength waste streams which are presently being disposed of at an EPA designated dump site. The new fishmeal plant will also have an odor control system. This $6.5 million fishmeal plant is the corner stone of StarKist Samoa's source reduction program.

Over the past three years, StarKist Samoa has spent over $400,000 on refurbishing equipment at the fishmeal plant.

Stormwater Prevention Plan. In March of 1993, StarKist Samoa submitted its Storm Water Pollution Prevention Plan to the US EPA and AS EPA in compliance with its General Storm Water Permit.

As part of its Best Management Practices, StarKist Samoa initiated stormwater improvement projects in excess of $400,000 to eliminate storm drains and runoffs and greatly minimize the commingling of process water and stormwater.

Specifically, the following tasks have been completed as of October 7, 1993:

1. Eight unused outfall pipes were sealed with concrete to ensure no process water can inadvertently be discharged into the harbor.

2. The Boiler Room is bunded and a catchment grating installed to direct all wash down water to the Wastewater Treatment Plant. This ensures that no process water will escape to the alley.

3. A bund was installed around the can wash pit to ensure any overflow will stay inside the pit.

4. The drain from the Busse Unloader area was diverted from the storm water system to the Wastewater Treatment Plant inside the Packing Room.

5. The storm water grate in alley #2 adjacent to the fish meal plant was diverted to the Packing Room wastewater sump. It was sealed and isolated from the storm water system.

6. The grated storm water inlet next to the waste water treatment tanks was relocated approximately 45 feet further up-slope in the alley. This eliminated any possibility that process water from the Wastewater Treatment tank area or the Compressor Room could drain into the storm drainage system.

7. The storm drain inlet located at the end of the alley between Freezer #2 and #3 has been reconstructed to exclude any dock washdown water.

8. The gap in the foundation at the back of the Fish Meal Plant has been filled in with concrete to prevent washdown water from escaping and entering the storm drain system.

9. All storm drain covers in areas where there are fish processing have been sealed off.

10. A new 140 feet by 8 feet concrete access road at the West end of the Can Plant was installed to ensure no oil or hazardous wastes will get into the storm water system from accidental spills.

11. All storm water down spouts have been sealed to ensure no process water can enter the storm drainage system

12. Approximately 50 percent of the 600 feet of four inch PVC pipe connecting the fuel tank bund to the Wastewater treatment system in the Packing Room have been installed.

13. The section of the dock where the old salt water pumps were located is covered with a steel plate at present. The steel plate is not sufficiently watertight to insure wash down water cannot leak into the harbor . This opening will be filled with concrete to become a permanent part of the dock .

Essentially most of the capital improvement projects have been completed. The only remaining item to be completed is the replacement of the existing diesel tank and paving of the bunded area. Any contaminated soil in the bunded area will be removed or remediated. The estimated time frame for completion is 6 months.

One major area of concern to StarKist Samoa is the overflow of contaminated stormwater from the truck loading area east of StarKist's property through the public right-of-way to StarKist's wastewater treatment plant. This problem has been brought to the attention of the US EPA and AS EPA.

Waste Oil Recycling. In order to minimize the input of diesel and motor oil into its waste streams, StarKist Samoa has been for some time burning its waste oil in its boilers. Arrangements have also been made with the American Samoa Power Authority to incinerate some of StarKist Samoa's waste oil.

Water Conservation Program. StarKist Samoa implemented its water conservation program approximately two years ago. This program consists of:

1. Installation of flow reduction devices such as water spray guns on water hoses.

2. Increased dry sweeping of the packing room floors prior to wet cleaning.

3. Use of reclaimed retort water as boiler feed water.

4. Installation of individual water meters in over 14 work areas such as the packing room, fishmeal room, dock area, can wash area, etc. to better track water usages throughout the plant.

5. Formation of a Quality Improvement Team under StarKist's Total Quality Management Program to track water usages throughout the plant.

The cumulative result of these efforts is a water usage reduction of approximately 10 percent. The Table below shows typical results for a four week period since installation of the water guns.

Week of Jan 03, 1993	4,942,060 gallons
Week of Jan 10, 1993	4,908,150 gallons
Week of Jan 17, 1993	4,854,690 gallons
Week of Jan 24, 1993	4,492,140 gallons

Bilge Water Program. StarKist Samoa is making arrangement with Southwest Marine to collect and treat the bilge water of fishing vessels docked at its facility.

Training of Personnel in Safety and Environmental Issues. StarKist Samoa began implementation of the following training programs:

The Honolulu firm of Environmental Technologies International (ETI) was retained by StarKist Samoa to conduct comprehensive environmental and safety training on-site. The cost was in excess of $ 25,000. As of June 1993, 16 employees have received 24-hour emergency response

training, 15 employees on responsibilities of large quantity generators, 15 on hazardous waste site cleanup, and 14 on safe transportation of hazardous materials.

An emergency evacuation plan was also prepared by ETI for the entire cannery at a cost of $10,000.

The StarKist Foods' Corporate Safety Manager conducted a 16-hour safety training program for all department managers in May of 1993 and approximately 60 line supervisors in July of 1993. The Corporate Environmental Manager conducted the 3-hour Hazard Communication portion of the Safety Training.

Heavy Metals. The sources of heavy metals have been addressed in StarKist Samoa's report to US EPA dated July 30, 1991. In this report, the sources of heavy metals are from the Bay water which is used by the cannery for thawing frozen fish.

Since the submission of this report on heavy metals, StarKist Samoa relocated the thaw water intake to a distance of 80 feet from shore and at a depth of 20 feet in December of 1991. The analyses of metals in the thaw water showed the levels of cadmium, chromium, lead, mercury and zinc have all significantly reduced since extension of the intake pipe. See Table 1 below.

Two samples of StarKist Samoa's effluent collected on February 17, 1993 and June 29, 1993 showed concentrations of cadmium, chromium,lead and mercury to be **below** detection limits. Zinc concentrations in the effluent were 0.092 mg/l and 0.147 mg/l respectively.

Table 1

	Jan 90	Nov 90	July 90	Before Average	After Jan 92
Cadmium	0.060	0.059	0.030	0.050	0.010
Chromium	0.200	0.120	0.170	0.160	0.030
Lead	0.700	0.170	0.370	0.413	0.010
Mercury	0.005	0.042	0.002	0.016	0.004
Zinc	0.210	0.270	0.220	0.233	0.045

All concentrations in mg/l.

D:\samoa\report.ppp

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Mike

CLIENT: ASEPA

ATTENTION: Sheila Wiegman

FILE No.: 419
REPORT DATE: 6/28/93
PAGE: 1 of 2

REPORT OF ANALYTICAL RESULTS

SAMPLE TYPE: Water
DATE SAMPLED: 1/22/93

AECOS LOG No.: 6425
DATE RECEIVED: 2/16/93

ANALYTE (UNITS)	Nitrate/ Nitrite (mgN/L)	Total Nitrogen (mgN/L)	Total Kjeldahl Nitrogen (mgN/L)	Total Phosphorus (mgP/L)	Chlorophyll a (mg/m³)
Analysis Date/ Analyst ID ⇨	5/26 jr	6/16 klm/jr	calc.	5/29 dh	5/9 jr/lr
SAMPLE ID ⇩					
5-3	0.012	0.066	0.054	0.012	1.25
5-60	0.024	0.099	0.075	0.018	1.19
6-3	0.018	0.124	0.106	0.019	0.21
6-60	0.018	0.094	0.076	0.031	0.18
7-3	0.022	0.087	0.065	0.015	0.95
7-60	0.015	0.058	0.043	0.011	0.54
8-3	0.032	0.106	0.074	0.019	0.45
8-60	0.026	0.094	0.068	0.016	0.71
8A-3	0.030	0.133	0.103	0.023	0.82
8A-60	0.030	0.155	0.125	0.024	0.74
9-3	0.029	0.131	0.102	0.020	0.17
9-60	0.030	0.133	0.103	0.019	0.18
9A-3	0.016	0.070	0.054	0.010	0.44

for Michele S. Hasegawa
J. Mello, Laboratory Director

Mike
Rev data
2 copies - one for each county.

CLIENT: ASEPA

ATTENTION: Sheila Wiegman

FILE No.: 419
REPORT DATE: 6/28/93
PAGE: 2 of 2

LOG No.: 6425

ANALYTE (UNITS)	Nitrate/ Nitrite (mgN/L)	Total Nitrogen (mgN/L)	Total Kjeldahl Nitrogen (mgN/L)	Total Phosphorus (mgP/L)	CHL a (mg/m^3)
SAMPLE ID ⇩					
9A-60	0.018	0.089	0.071	0.013	0.42
10-3	0.016	0.089	0.073	0.012	0.80
10-60	0.018	0.102	0.084	0.014	1.03
11-3	0.016	0.086	0.070	0.010	0.47
11-60	0.022	0.110	0.088	0.014	0.45
11A-3	0.014	0.108	0.094	0.014	1.28
11A-60	0.020	0.076	0.056	0.012	1.01
12-3	0.014	0.170	0.156	0.022	1.28
12-60	0.012	0.131	0.119	0.016	0.98
13-3	0.018	0.144	0.126	0.024	no sample
13-60	0.024	0.176	0.152	0.028	0.93
14-3	0.021	0.086	0.065	0.017	0.43
14-60	0.018	0.086	0.068	0.012	1.16
15-3	0.018	0.095	0.077	0.016	0.35
15-60	0.022	0.111	0.089	0.019	0.33
16-3	0.037	0.130	0.093	0.022	0.62
16-60	0.027	0.097	0.070	0.014	0.45
17-3	0.018	0.086	0.068	0.014	0.38
17-60	0.017	0.097	0.080	0.014	1.08
18-3	0.029	0.128	0.099	0.020	1.02
18-60	0.012	0.090	0.078	0.017	1.24

Rec'd on 6/21/93.

AECOS

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CLIENT: ASEPA

ATTENTION: Sheila Wiegman

FILE No.:	419
REPORT DATE:	6/9/93
PAGE:	1 of 2

REPORT OF ANALYTICAL RESULTS

SAMPLE TYPE: Water
DATE SAMPLED: 3/9/93

AECOS LOG No.: 6538
DATE RECEIVED: 3/18/93

ANALYTE (UNITS)	Nitrate/ Nitrite (mgN/L)	Total Nitrogen (mgN/L)	Kjeldahl Nitrogen (mgN/L)	Total Phosphorus (mgP/L)	CHL a (mg/m³)
Analysis Date/ Analyst ID ⇨	5/15 kk	5/15 kk	5/15 kk	5/15 kk	6/8 dt
SAMPLE ID ⇩					
5-3	0.008	0.080	0.072	0.011	0.59
5-60	0.009	0.069	0.060	0.008	0.31
6-3	0.008	0.041	0.033	0.007	0.36
6-60	0.007	0.035	0.028	0.017	0.24
7-3	0.006	0.071	0.065	0.012	0.80
7-60	0.004	0.237	0.233	0.006	0.48
8-3	0.005	0.052	0.047	0.016	0.85
8-60	0.004	0.024	0.020	0.013	0.34
8A-3	0.012	0.035	0.023	0.011	0.95
8A-60	0.011	0.164	0.153	0.006	0.65
9-3	0.008	0.091	0.083	0.016	0.80
9-60	0.009	0.088	0.079	0.006	0.51
9A-3	0.007	0.136	0.129	0.009	0.67

J. Mello, Laboratory Director

Recd on 6/21/93

CLIENT: ASEPA

ATTENTION: Sheila Wiegman

FILE No.: 419
REPORT DATE: 6/9/93
PAGE: 2 of 2

LOG No.: 6538

ANALYTE (UNITS)	Nitrate/ Nitrite (mgN/L)	Total Nitrogen (mgN/L)	Kjeldahl Nitrogen (mgN/L)	Total Phosphorus (mgP/L)	CHL a (mg/m³)
SAMPLE ID ⇩					
9A-60	0.008	0.080	0.072	0.015	0.67
10-3	0.019	0.088	0.069	0.007	0.56
10-60	0.007	0.028	0.021	0.018	0.52
11-3	0.007	0.101	0.094	0.010	0.56
11-60	0.004	0.088	0.084	0.019	0.50
11A-3	0.004	0.041	0.037	0.023	0.82
11A-60	0.009	0.088	0.079	0.005	0.56
12-3	0.006	0.071	0.065	0.007	0.86
12-60	0.006	0.052	0.046	0.006	1.85
13-3	0.008	0.102	0.094	0.011	2.22
13-60	0.007	0.039	0.032	0.014	1.66
14-3	0.004	0.064	0.060	0.011	0.66
14-60	0.009	0.052	0.043	0.016	0.57
15-3	0.007	0.115	0.108	0.013	0.61
15-60	0.006	0.115	0.109	0.011	0.56
16-3	0.004	0.039	0.035	0.007	0.67
16-60	0.008	0.147	0.139	0.014	0.56
17-3	0.005	0.115	0.110	0.006	0.93
17-60	0.009	0.090	0.081	0.006	0.67
18-3	0.005	0.090	0.085	0.006	0.84
18-60	0.006	0.090	0.084	0.004	0.35

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JOB#: 419
DATE: 11/12/92

Pago Pago Harbor and Stream Monthly Water Quality Study

August 6, 1992 Sampling [AECOS Log #5951]

HARBOR STATION	NITRATE/ NITRITE mg N/l	TOTAL N mg N/l	KJELDAHL N mg N/l	TOTAL P mg P/l	CHL a mg/m^3
5-3	0.047	0.166	0.119	0.013	1.38
5-60	<0.001	0.120	0.120	0.004	0.49
6-3	0.024	0.132	0.108	0.008	0.74
6-60	0.013	0.130	0.117	0.002	0.58
7-3	0.032	0.132	0.100	0.008	0.23
7-60	0.002	0.094	0.092	0.003	0.18
8-3	<0.001	0.123	0.123	0.014	0.65
8-60	0.056	0.183	0.127	0.022	0.62
8A-3	0.044	0.175	0.131	0.023	2.66
8A-60	0.014	0.169	0.155	0.020	1.20
9-3	0.036	0.212	0.176	0.022	0.64
9-60	0.016	0.148	0.132	0.011	1.33
9A-3	0.014	0.183	0.169	0.016	1.41
9A-60	0.005	0.108	0.103	0.011	0.93
10-3	0.017	0.160	0.143	0.012	1.68
10-60	0.001	0.134	0.133	0.006	0.47
11-3	0.024	0.197	0.173	0.018	0.26
11-60	<0.001	0.116	0.116	0.005	0.53
11A-3	0.021	0.222	0.201	0.016	0.48
11A-60	0.008	0.154	0.146	0.010	1.90
12-3	0.021	0.221	0.200	0.014	0.38
12-60	0.013	0.237	0.224	0.012	0.29

Pago Pago Harbor and Stream Monthly Water Quality Study

August 6, 1992 Sampling [AECOS Log #5951]

HARBOR STATION	NITRATE/ NITRITE mg N/l	TOTAL N mg N/l	KJELDAHL N mg N/l	TOTAL P mg P/l	CHL a mg/m^3
13-3	0.066	0.389	0.323	0.020	0.94
13-30	0.004	0.147	0.143	0.010	0.90
14-3	0.026	0.183	0.157	0.011	1.50
14-60	0.014	0.550	0.536	0.082	0.21
15-3	0.025	0.200	0.175	0.018	0.83
15-60	0.002	0.178	0.176	0.015	0.47
16-3	0.036	0.337	0.301	0.017	1.00
16-60	0.002	0.150	0.148	0.190	0.71
17-3	0.026	0.239	0.213	0.021	1.78
17-60	0.005	0.244	0.239	0.011	1.11
18-3	0.010	0.216	0.206	0.024	6.58
18-60	0.057	0.256	0.199	0.036	4.47

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JOB #: 419
DATE: 05/13/93

CLIENT: ASEPA
SAMPLES OF: Harbor water
DATE RECEIVED: 12/24/92

ATTN: Sheila Wiegman
DATE SAMPLED: ---
LOG #: 6309

Samples of Pago Pago Harbor Monthly Water Quality Study

Analysis:	Nitrate + Nitrite	Total Nitrogen	Kjeldahl Nitrogen	Total Phosphorous	Chlorophyll α
Units:	mg N/L	mg N/L	mg N/L	mg P/L	mg/m^3
Station:					
5-3	No Samples	No Samples	No Samples	No Samples	No Samples
5-60	No Samples	No Samples	No Samples	No Samples	No Samples
6-3	0.009	0.138	0.129	0.018	0.96
6-60	0.006	0.103	0.097	0.018	0.57
7-3	0.002	0.176	0.174	0.036	1.89
7-60	0.004	0.154	0.150	0.018	0.75
8-3	<0.001	0.133	0.133	0.016	2.66
8-60	<0.001	0.120	0.120	0.014	2.61
8A-3	<0.001	0.150	0.150	0.020	2.09
8A-60	<0.001	0.141	0.141	0.019	1.93
9-3	<0.001	0.166	0.166	0.022	1.23
9-60	0.010	0.151	0.141	0.020	1.44
9A-3	<0.001	0.278	0.278	0.034	1.44
9A-60	0.001	0.108	0.107	0.010	1.63
10-3	0.010	0.138	0.128	0.020	2.44
10-60	<0.001	0.097	0.097	0.010	1.56
11-3	<0.001	0.127	0.127	0.020	1.88
11-60	<0.001	0.109	0.109	0.016	1.54
11A-3	<0.001	0.156	0.156	0.026	1.32
11A-60	<0.001	0.148	0.148	0.025	1.95
12-3	<0.001	0.188	0.188	0.030	4.70
12-60	0.010	0.183	0.173	0.026	3.15
13-3	0.002	0.411	0.409	0.088	7.66
13-60	0.002	0.193	0.191	0.027	2.74
14-3	0.002	0.143	0.141	0.014	1.49
14-60	0.001	0.151	0.150	0.016	2.05
15-3	0.001	0.134	0.133	0.014	1.56
15-60	0.005	0.111	0.106	0.014	1.85
16-3	0.002	0.114	0.112	0.020	2.78
16-60	0.005	0.103	0.098	0.010	2.00
17-3	0.007	0.112	0.105	0.016	2.36
17-60	0.003	0.110	0.107	0.014	1.79
18-3	0.005	0.117	0.112	0.010	1.40
18-60	0.002	0.108	0.106	0.012	1.98

Pago Pago Harbor and Stream Monthly Water Quality Study

October 6, 1992 Sampling [AECOS Log #6118]

HARBOR STATION	NITRATE/ NITRITE mg N/l	TOTAL N mg N/l	KJELDAHL N mg N/l	TOTAL P mg P/l	CHL *a* mg/m^3
13-3	0.016	0.229	0.213	0.043	0.85
13-30	<0.001	0.144	0.144	0.017	0.65
14-3	0.006	0.106	0.100	0.001	0.52
14-60	0.004	0.134	0.130	21.1*	0.78
15-3	0.012	0.150	0.138	0.017	0.67
15-60	0.012	0.129	0.117	0.019	0.42
16-3	0.006	0.183	0.177	0.017	0.47
16-60	0.004	0.137	0.133	0.018	0.47
17-3	0.008	0.144	0.136	0.019	0.44
17-60	0.011	0.164	0.153	0.019	0.64
18-3	0.001	0.116	0.115	0.016	0.28
18-60	0.005	0.134	0.129	0.018	0.46

* value verified by repeat analysis.

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JOB#: 419
DATE: 01/28/93

Pago Pago Harbor and Stream Monthly Water Quality Study

October 6, 1992 Sampling [AECOS Log #6118]

HARBOR STATION	NITRATE/ NITRITE mg N/l	TOTAL N mg N/l	KJELDAHL N mg N/l	TOTAL P mg P/l	CHL a mg/m^3
5-3	0.007	0.149	0.142	0.011	0.19
5-60	0.001	0.073	0.072	0.001	0.16
6-3	0.005	0.078	0.073	0.001	0.28
6-60	0.004	0.151	0.147	0.002	0.28
7-3	0.006	0.122	0.116	0.012	0.38
7-60	0.004	0.186	0.182	0.016	0.25
8-3	0.006	0.091	0.085	0.008	0.52
8-60	0.004	0.067	0.063	0.012	0.37
8A-3	0.010	0.137	0.127	0.010	0.45
8A-60	0.005	0.156	0.151	0.009	0.33
9-3	0.003	0.158	0.155	0.009	0.26
9-60	0.013	0.105	0.092	0.012	0.27
9A-3	0.002	0.121	0.119	0.010	0.18
9A-60	0.001	0.110	0.109	0.010	0.30
10-3	0.010	0.117	0.107	0.009	0.36
10-60	0.005	0.113	0.108	0.009	0.31
11-3	0.001	0.116	0.115	0.007	0.61
11-60	0.001	0.357	0.356	0.041	0.49
11A-3	0.002	0.103	0.101	0.008	0.51
11A-60	0.002	0.120	0.118	0.009	0.71
12-3	0.002	0.172	0.170	0.012	0.81
12-60	0.001	0.179	0.178	0.012	0.70

Sample Site	Temp. C			TURB.	D.O. mg/l	TSS mg/l	SECCHI DEPTH		NUTRIENTS (mg/l) TKN	NH3N	TP	COLIFORM
18-3 S	28.7			0.4	7.4	211 mg/l	30'					3,000 nl
18-60				0.4		207 mg/l						3,000 nl
17-3 E	28.8			0.5	8.0	185 mg/l	40'					3,000 nl
17-60				0.5		429 mg/l						3,000 nl
16-3 W	28.9			0.5	7.4	307 mg/l	48'					3,000 nl
16-60				0.4		291 mg/l						3,000 nl
15-3 N	28.8			0.7	6.9	304 mg/l	65'					3,000 nl
15-60				0.5		295 mg/l						3,000 nl
14-3 C	28.8			0.5	7.4	308 mg/l	45'					3,000 nl
14-60				0.5		301 mg/l						3,000 nl
13-3	28.4			3.5	7.6	213 mg/l	22'					2,000 nl
13-60				1.4		245 mg/l						3,000 nl
12-3	28.8			0.5	7.4	246 mg/l	29'					3,000 nl
12-60				0.7		278 mg/l						3,000 nl
11-A-3	28.6			0.5	7.0	310 mg/l	32'					3,000 nl
11-A-60				0.5		285 mg/l						3,000 nl
11-3	28.2			0.5	7.4	302 mg/l	42'					3,000 nl
11-60				0.4		319 mg/l						3,000 nl
10-3	28.8			0.7	7.1	317 mg/l	31'					3,000 nl
10-60				0.5		291 mg/l						3,000 nl
9 A-3	29			0.5	7.1	219 mg/l	47'					3,000 nl
9 A-60				0.4		207 mg/l						3,000 nl
9-3	28.8			0.5	6.7	290 mg/l	65'					3,000 nl
9-60				0.4		276 mg/l						3,000 nl
8 A-3	28.8			0.5	7.0	282 mg/l	65'					3,000 nl
8 A-60				0.4		276 mg/l						3,000 nl
8-3	28.8			0.4	7.4	287 mg/l	34'					3,000 nl
8-60				0.4		272 mg/l						3,000 nl
7-3	28.8			0.4	7.4	285 mg/l	34'					3,000 nl
7-60				0.4		276 mg/l						3,000 nl
6-3	29			0.4	7.4	222 mg/l	38'					3,000 nl
6-60				0.3		361 mg/l						3,000 nl
5-3	28.7			0.5	7.5	388 mg/l	35'					3,000 nl
5-60				0.4		373 mg/l						3,000 nl

AECOS
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Telephone: (808) 254-5884

CLIENT: ASEPA

ATTENTION: Sheila Wiegman

FILE No.: 419
REPORT DATE: 6/28/93
PAGE: 1 of 2

REPORT OF ANALYTICAL RESULTS

SAMPLE TYPE: Water
DATE SAMPLED: 1/22/93

AECOS LOG No.: 6425
DATE RECEIVED: 2/16/93

ANALYTE (UNITS)	Nitrate/ Nitrite (mgN/L)	Total Nitrogen (mgN/L)	Total Kjeldahl Nitrogen (mgN/L)	Total Phosphorus (mgP/L)	Chlorophyll a (mg/m³)
Analysis Date/ Analyst ID ⇨	5/26 jr	6/16 klm/jr	calc.	5/29 dh	5/9 jr/lr
SAMPLE ID ⇩					
5-3	0.012	0.066	0.054	0.012	1.25
5-60	0.024	0.099	0.075	0.018	1.19
6-3	0.018	0.124	0.106	0.019	0.21
6-60	0.018	0.094	0.076	0.031	0.18
7-3	0.022	0.087	0.065	0.015	0.95
7-60	0.015	0.058	0.043	0.011	0.54
8-3	0.032	0.106	0.074	0.019	0.45
8-60	0.026	0.094	0.068	0.016	0.71
8A-3	0.030	0.133	0.103	0.023	0.82
8A-60	0.030	0.155	0.125	0.024	0.74
9-3	0.029	0.131	0.102	0.020	0.17
9-60	0.030	0.133	0.103	0.019	0.18
9A-3	0.016	0.070	0.054	0.010	0.44

for Michele S. Hasegawa
J. Mello, Laboratory Director

CLIENT: ASEPA

ATTENTION: Sheila Wiegman

FILE No.: 419
REPORT DATE: 6/28/93
PAGE: 2 of 2

LOG No.: 6425

ANALYTE (UNITS)	Nitrate/ Nitrite (mgN/L)	Total Nitrogen (mgN/L)	Total Kjeldahl Nitrogen (mgN/L)	Total Phosphorus (mgP/L)	CHL a (mg/m^3)
SAMPLE ID ⇩					
9A-60	0.018	0.089	0.071	0.013	0.42
10-3	0.016	0.089	0.073	0.012	0.80
10-60	0.018	0.102	0.084	0.014	1.03
11-3	0.016	0.086	0.070	0.010	0.47
11-60	0.022	0.110	0.088	0.014	0.45
11A-3	0.014	0.108	0.094	0.014	1.28
11A-60	0.020	0.076	0.056	0.012	1.01
12-3	0.014	0.170	0.156	0.022	1.28
12-60	0.012	0.131	0.119	0.016	0.98
13-3	0.018	0.144	0.126	0.024	no sample
13-60	0.024	0.176	0.152	0.028	0.93
14-3	0.021	0.086	0.065	0.017	0.43
14-60	0.018	0.086	0.068	0.012	1.16
15-3	0.018	0.095	0.077	0.016	0.35
15-60	0.022	0.111	0.089	0.019	0.33
16-3	0.037	0.130	0.093	0.022	0.62
16-60	0.027	0.097	0.070	0.014	0.45
17-3	0.018	0.086	0.068	0.014	0.38
17-60	0.017	0.097	0.080	0.014	1.08
18-3	0.029	0.128	0.099	0.020	1.02
18-60	0.012	0.090	0.078	0.017	1.24

Rec'd on 6/21/93.

AECOS

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CLIENT: ASEPA

ATTENTION: Sheila Wiegman

FILE No.:	419
REPORT DATE:	6/9/93
PAGE:	1 of 2

REPORT OF ANALYTICAL RESULTS

SAMPLE TYPE: Water
DATE SAMPLED: 3/9/93

AECOS LOG No.: 6538
DATE RECEIVED: 3/18/93

ANALYTE (UNITS)	Nitrate/ Nitrite (mgN/L)	Total Nitrogen (mgN/L)	Kjeldahl Nitrogen (mgN/L)	Total Phosphorus (mgP/L)	CHL a (mg/m³)
Analysis Date/ Analyst ID ⇨	5/15 kk	5/15 kk	5/15 kk	5/15 kk	6/8 dt
SAMPLE ID ⇩					
5-3	0.008	0.080	0.072	0.011	0.59
5-60	0.009	0.069	0.060	0.008	0.31
6-3	0.008	0.041	0.033	0.007	0.36
6-60	0.007	0.035	0.028	0.017	0.24
7-3	0.006	0.071	0.065	0.012	0.80
7-60	0.004	0.237	0.233	0.006	0.48
8-3	0.005	0.052	0.047	0.016	0.85
8-60	0.004	0.024	0.020	0.013	0.34
8A-3	0.012	0.035	0.023	0.011	0.95
8A-60	0.011	0.164	0.153	0.006	0.65
9-3	0.008	0.091	0.083	0.016	0.80
9-60	0.009	0.088	0.079	0.006	0.51
9A-3	0.007	0.136	0.129	0.009	0.67

J. Mello, Laboratory Director

Recd on 6/21/93

CLIENT: ASEPA

ATTENTION: Sheila Wiegman

FILE No.: 419
REPORT DATE: 6/9/93
PAGE: 2 of 2

LOG No.: 6538

ANALYTE (UNITS)	Nitrate/ Nitrite (mgN/L)	Total Nitrogen (mgN/L)	Kjeldahl Nitrogen (mgN/L)	Total Phosphorus (mgP/L)	CHL a (mg/m³)
SAMPLE ID ⇩					
9A-60	0.008	0.080	0.072	0.015	0.67
10-3	0.019	0.088	0.069	0.007	0.56
10-60	0.007	0.028	0.021	0.018	0.52
11-3	0.007	0.101	0.094	0.010	0.56
11-60	0.004	0.088	0.084	0.019	0.50
11A-3	0.004	0.041	0.037	0.023	0.82
11A-60	0.009	0.088	0.079	0.005	0.56
12-3	0.006	0.071	0.065	0.007	0.86
12-60	0.006	0.052	0.046	0.006	1.85
13-3	0.008	0.102	0.094	0.011	2.22
13-60	0.007	0.039	0.032	0.014	1.66
14-3	0.004	0.064	0.060	0.011	0.66
14-60	0.009	0.052	0.043	0.016	0.57
15-3	0.007	0.115	0.108	0.013	0.61
15-60	0.006	0.115	0.109	0.011	0.56
16-3	0.004	0.039	0.035	0.007	0.67
16-60	0.008	0.147	0.139	0.014	0.56
17-3	0.005	0.115	0.110	0.006	0.93
17-60	0.009	0.090	0.081	0.006	0.67
18-3	0.005	0.090	0.085	0.006	0.84
18-60	0.006	0.090	0.084	0.004	0.35

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JOB#: 419
DATE: 11/12/92

Pago Pago Harbor and Stream Monthly Water Quality Study

August 6, 1992 Sampling [AECOS Log #5951]

HARBOR STATION	NITRATE/ NITRITE mg N/l	TOTAL N mg N/l	KJELDAHL N mg N/l	TOTAL P mg P/l	CHL a mg/m^3
5-3	0.047	0.166	0.119	0.013	1.38
5-60	<0.001	0.120	0.120	0.004	0.49
6-3	0.024	0.132	0.108	0.008	0.74
6-60	0.013	0.130	0.117	0.002	0.58
7-3	0.032	0.132	0.100	0.008	0.23
7-60	0.002	0.094	0.092	0.003	0.18
8-3	<0.001	0.123	0.123	0.014	0.65
8-60	0.056	0.183	0.127	0.022	0.62
8A-3	0.044	0.175	0.131	0.023	2.66
8A-60	0.014	0.169	0.155	0.020	1.20
9-3	0.036	0.212	0.176	0.022	0.64
9-60	0.016	0.148	0.132	0.011	1.33
9A-3	0.014	0.183	0.169	0.016	1.41
9A-60	0.005	0.108	0.103	0.011	0.93
10-3	0.017	0.160	0.143	0.012	1.68
10-60	0.001	0.134	0.133	0.006	0.47
11-3	0.024	0.197	0.173	0.018	0.26
11-60	<0.001	0.116	0.116	0.005	0.53
11A-3	0.021	0.222	0.201	0.016	0.48
11A-60	0.008	0.154	0.146	0.010	1.90
12-3	0.021	0.221	0.200	0.014	0.38
12-60	0.013	0.237	0.224	0.012	0.29

Pago Pago Harbor and Stream Monthly Water Quality Study

August 6, 1992 Sampling [AECOS Log #5951]

HARBOR STATION	NITRATE/ NITRITE mg N/l	TOTAL N mg N/l	KJELDAHL N mg N/l	TOTAL P mg P/l	CHL *a* mg/m^3
13-3	0.066	0.389	0.323	0.020	0.94
13-30	0.004	0.147	0.143	0.010	0.90
14-3	0.026	0.183	0.157	0.011	1.50
14-60	0.014	0.550	0.536	0.082	0.21
15-3	0.025	0.200	0.175	0.018	0.83
15-60	0.002	0.178	0.176	0.015	0.47
16-3	0.036	0.337	0.301	0.017	1.00
16-60	0.002	0.150	0.148	0.190	0.71
17-3	0.026	0.239	0.213	0.021	1.78
17-60	0.005	0.244	0.239	0.011	1.11
18-3	0.010	0.216	0.206	0.024	6.58
18-60	0.057	0.256	0.199	0.036	4.47

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Telephone: (808) 254-5884

JOB #: 419
DATE: 05/13/93

CLIENT: ASEPA
SAMPLES OF: Harbor water
DATE RECEIVED: 12/24/92

ATTN: Sheila Wiegman
DATE SAMPLED: ---
LOG #: 6309

Samples of Pago Pago Harbor Monthly Water Quality Study

Analysis:	Nitrate + Nitrite	Total Nitrogen	Kjeldahl Nitrogen	Total Phosphorous	Chlorophyll α
Units:	mg N/L	mg N/L	mg N/L	mg P/L	mg/m^3
Station:					
5-3	No Samples	No Samples	No Samples	No Samples	No Samples
5-60	No Samples	No Samples	No Samples	No Samples	No Samples
6-3	0.009	0.138	0.129	0.018	0.96
6-60	0.006	0.103	0.097	0.018	0.57
7-3	0.002	0.176	0.174	0.036	1.89
7-60	0.004	0.154	0.150	0.018	0.75
8-3	<0.001	0.133	0.133	0.016	2.66
8-60	<0.001	0.120	0.120	0.014	2.61
8A-3	<0.001	0.150	0.150	0.020	2.09
8A-60	<0.001	0.141	0.141	0.019	1.93
9-3	<0.001	0.166	0.166	0.022	1.23
9-60	0.010	0.151	0.141	0.020	1.44
9A-3	<0.001	0.278	0.278	0.034	1.44
9A-60	0.001	0.108	0.107	0.010	1.63
10-3	0.010	0.138	0.128	0.020	2.44
10-60	<0.001	0.097	0.097	0.010	1.56
11-3	<0.001	0.127	0.127	0.020	1.88
11-60	<0.001	0.109	0.109	0.016	1.54
11A-3	<0.001	0.156	0.156	0.026	1.32
11A-60	<0.001	0.148	0.148	0.025	1.95
12-3	<0.001	0.188	0.188	0.030	4.70
12-60	0.010	0.183	0.173	0.026	3.15
13-3	0.002	0.411	0.409	0.088	7.66
13-60	0.002	0.193	0.191	0.027	2.74
14-3	0.002	0.143	0.141	0.014	1.49
14-60	0.001	0.151	0.150	0.016	2.05
15-3	0.001	0.134	0.133	0.014	1.56
15-60	0.005	0.111	0.106	0.014	1.85
16-3	0.002	0.114	0.112	0.020	2.78
16-60	0.005	0.103	0.098	0.010	2.00
17-3	0.007	0.112	0.105	0.016	2.36
17-60	0.003	0.110	0.107	0.014	1.79
18-3	0.005	0.117	0.112	0.010	1.40
18-60	0.002	0.108	0.106	0.012	1.98

Pago Pago Harbor and Stream Monthly Water Quality Study

October 6, 1992 Sampling [AECOS Log #6118]

HARBOR STATION	NITRATE/ NITRITE mg N/l	TOTAL N mg N/l	KJELDAHL N mg N/l	TOTAL P mg P/l	CHL *a* mg/m^3
13-3	0.016	0.229	0.213	0.043	0.85
13-30	<0.001	0.144	0.144	0.017	0.65
14-3	0.006	0.106	0.100	0.001	0.52
14-60	0.004	0.134	0.130	21.1*	0.78
15-3	0.012	0.150	0.138	0.017	0.67
15-60	0.012	0.129	0.117	0.019	0.42
16-3	0.006	0.183	0.177	0.017	0.47
16-60	0.004	0.137	0.133	0.018	0.47
17-3	0.008	0.144	0.136	0.019	0.44
17-60	0.011	0.164	0.153	0.019	0.64
18-3	0.001	0.116	0.115	0.016	0.28
18-60	0.005	0.134	0.129	0.018	0.46

* value verified by repeat analysis.

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JOB#: 419
DATE: 01/28/93

Pago Pago Harbor and Stream Monthly Water Quality Study

October 6, 1992 Sampling [AECOS Log #6118]

HARBOR STATION	NITRATE/ NITRITE mg N/l	TOTAL N mg N/l	KJELDAHL N mg N/l	TOTAL P mg P/l	CHL a mg/m^3
5-3	0.007	0.149	0.142	0.011	0.19
5-60	0.001	0.073	0.072	0.001	0.16
6-3	0.005	0.078	0.073	0.001	0.28
6-60	0.004	0.151	0.147	0.002	0.28
7-3	0.006	0.122	0.116	0.012	0.38
7-60	0.004	0.186	0.182	0.016	0.25
8-3	0.006	0.091	0.085	0.008	0.52
8-60	0.004	0.067	0.063	0.012	0.37
8A-3	0.010	0.137	0.127	0.010	0.45
8A-60	0.005	0.156	0.151	0.009	0.33
9-3	0.003	0.158	0.155	0.009	0.26
9-60	0.013	0.105	0.092	0.012	0.27
9A-3	0.002	0.121	0.119	0.010	0.18
9A-60	0.001	0.110	0.109	0.010	0.30
10-3	0.010	0.117	0.107	0.009	0.36
10-60	0.005	0.113	0.108	0.009	0.31
11-3	0.001	0.116	0.115	0.007	0.61
11-60	0.001	0.357	0.356	0.041	0.49
11A-3	0.002	0.103	0.101	0.008	0.51
11A-60	0.002	0.120	0.118	0.009	0.71
12-3	0.002	0.172	0.170	0.012	0.81
12-60	0.001	0.179	0.178	0.012	0.70

Sample Site	Temp. C	pH	TRB.	D.O. mg/l	TSS mg/l	SECCI DEPTH	IN	NUTRIENTS (mg/l) TKN	NH3N	TP	Others
18-3 S	28.7		0.4	7.4	211 mg/l	30'					3,000 nl
18-60			0.4		207 mg/l						3,000 nl
17-3 E	28.8		0.5	8.0	185 mg/l	40'					3,000 nl
17-60			0.5		289 mg/l						3,000 nl
16-3 W	28.9		0.5	7.4	307 mg/l	48'					3,000 nl
16-60			0.4		291 mg/l						3,000 nl
15-3 W	28.8		0.7	6.9	304 mg/l	65'					3,000 nl
15-60			0.5		295 mg/l						3,000 nl
14-3 C	28.8		0.5	7.4	308 mg/l	45'					3,000 nl
14-60			0.5		301 mg/l						3,000 nl
13-3	28.4		3.5	7.6	213 mg/l	22'					2,000 nl
13-60			1.4		245 mg/l						3,000 nl
12-3	28.8		0.5	7.4	246 mg/l	29'					3,000 nl
12-60			0.7		278 mg/l						3,000 nl
11-A-3	28.6		0.5	7.0	310 mg/l	32'					3,000 nl
11-A-60			0.5		285 mg/l						3,000 nl
11-3	28.2		0.5	7.4	302 mg/l	42'					3,000 nl
11-60			0.4		319 mg/l						3,000 nl
10-3	28.8		0.7	7.1	317 mg/l	31'					3,000 nl
10-60			0.5		291 mg/l						3,000 nl
9-A-3	29		0.5	7.1	219 mg/l	47'					3,000 nl
9-A-60			0.4		207 mg/l						3,000 nl
9-3	28.8		0.5	6.7	290 mg/l	65'					3,000 nl
9-60			0.4		276 mg/l						3,000 nl
8-A-3	28.8		0.5	7.0	282 mg/l	65'					3,000 nl
8-A-60			0.4		276 mg/l						3,000 nl
8-3	28.8		0.4	7.4	287 mg/l	34'					3,000 nl
8-60			0.4		272 mg/l						3,000 nl
7-3	28.8		0.4	7.4	285 mg/l	34'					3,000 nl
7-60			0.4		276 mg/l						3,000 nl
6-3	29		0.4	7.4	222 mg/l	38'					3,000 nl
6-60			0.3		361 mg/l						3,000 nl
5-3	28.7		0.5	7.5	388 mg/l	35'					3,000 nl
5-60			0.4		373 mg/l						3,000 nl

Engineers
Planners
Economists
Scientists

21 June 1995

OPE30702.EL.R5

Patricia N.N. Young
American Samoa Program Manager
Office of Pacific Islands and Native American Programs
U.S. Environmental Protection Agency
75 Hawthorne Street (E-4)
San Francisco, California 94105

Dear Pat:

Subject: Joint Cannery Outfall Effluent Bioassay Testing

Enclosed are two copies of a Technical Memorandum describing the results of the fifth episode (March 1995 sampling) of whole effluent bioassay testing done under StarKist Samoa and VCS Samoa Packing NPDES permit requirements. For the tests done on the March 1995 samples, we performed bioassays on both *Penaeus vannami* and *Mysidopsis bahia* for reasons described in the report. In the future we will use only a single species with *Penaeus vannami* being the preferred organism. Unless USEPA or ASEPA have specific concerns, we will continue performing the tests as described in this report. I have sent copies directly to Amy Wagner (USEPA) and Sheila Wiegman (ASEPA). The next test is scheduled for September/October 1995.

I have a question concerning one of Amy Wagner's comments in her memorandum of 17 February 1995, concerning the collection of samples for the priority pollutant scans to be done concurrently with the bioassay tests. She indicated that only VOA vials should be preserved before sampling and that a description of sample preservation and verification of pH should be a part of the Standard Operation Procedure (SOP) for sample collection. We typically use sample containers that have been prepared and sealed in the laboratory, with the preservatives in place. Given the difficulties of shipping to, and working in, American Samoa, and considering the nature of the studies being done, we feel this approach is adequate. If you disagree with our methods please let me know and we will determine how best to change our SOP to comply with EPA's requirements.

CH2M HILL 1111 Broadway, P.O. Box 12681, Oakland, CA 94604-2681 510 251-2426 Fax 510 893-8205

If you have any questions please feel free to call me at your convenience.

Sincerely,

CH2M HILL

Steven L. Costa
Project Manager

cc: Amy Wagner, USEPA Region IX, (1 copy of enclosure)
Norman Wei, StarKist Seafood Company (1 copy of enclosure)
James Cox, Van Camp Seafood Company (1 copy of enclosures)
Barry Mills, StarKist Samoa, Inc. (1 copy of enclosures)
Bill Perez, VCS Samoa Packing Company (1 copy of enclosures)
Kurt Kline, Advanced Biological Testing (1 copy of enclosure)
David Wilson, CH2M HILL/SEA (1 copy of enclosure)

PREPARED FOR: StarKist Samoa, Inc.
VCS Samoa Packing Company, Inc.

PREPARED BY: Steve Costa/CH2M HILL/SFO
Karen A. Glatzel/Glatzel & Associates

DATE: 20 June 1995

SUBJECT: **Bioassay Testing of Effluent**
March 1995 Sampling

PROJECT: OPE030702.EL.R5

Purpose

This memorandum presents the results of the effluent bioassay testing of the Joint Cannery Outfall effluent sample that was collected in October 1994. This is the fifth of the required semi-annual tests. Separate Technical Memoranda describe the results of concurrent effluent chemistry testing.

Study Objectives

Section D.1 of the StarKist Samoa and VCS Samoa Packing NPDES permits requires that semi-annual definitive acute bioassays (96-hour static bioassays) be conducted on the cannery effluent. The purpose of these bioassays is to determine whether, and at what effluent concentration, acute toxicity may be detected for the effluent.

USEPA has conducted a number of reviews of the effluent sampling, analysis, and bioassay tests. Attachment I provides the latest comments on the previous tests (USEPA, 17 February 1995). The comments on the sampling procedures have been incorporated into the revised Standard Operating Procedures (Attachment II). The comments on the bioassay testing procedures have been incorporated into the test procedures by the laboratory doing the tests, Advanced Biological Testing. (Comments on the high strength waste sampling and testing pertain to a separate study and are addressed within that study.)

These bioassays were originally specified to be conducted using the white shrimp, *Penaeus vannami* (postlarvae). In the event *Penaeus vannami* are not available at the time of the tests, a substitute species (*Mysidopsis bahia*) has been approved by U.S. EPA (CH2M HILL, 26 January 1995). Prior to the test there was evidence that *Penaeus vannami* would not be available (Attachment I). However, a source of this organism was found. Since the mysids had already been ordered, bioassays were conducted with both *Penaeus vannami*

and *Mysidopsis bahia*. This provided an opportunity to have side-by-side test with both organisms and will provide assistance in the evaluation of the overall bioassay testing study since previous tests have been run with each species and this may occur as well with future tests.

The acute bioassay effluent sampling must be concurrent with effluent sampling for priority pollutant chemical analysis. Effluent samples are to be collected as 24-hour composite samples. The effluent acute bioassay was conducted using a combined composite effluent sample made up from the composite effluent samples from the StarKist Samoa and VCS Samoa Packing facilities, as approved by EPA. This combined effluent bioassay is representative of the wastewater discharged from the joint cannery outfall to Pago Pago Harbor.

Effluent Sampling Methods

Between 0830 on March 23 and 0630 on March 24, 1995, 24-hour, flow-weighted, composite samples of final effluent were collected from both the StarKist Samoa and VCS Samoa Packing treatment plant discharges. Samples were collected from the established effluent sampling sites following the routine composite sample collection schedule for the plants. Detailed sampling procedures are provided in Attachment II.

A total of eight grab samples were collected into pre-cleaned 1-gallon plastic cubitainers at each plant. Samples were collected at approximately three-hour intervals over a 24 hour period. The samples were stored on ice until the completion of the 24-hour sampling period. After all samples were collected a flow-proportioned composite sample was prepared. The grab sample collection times and the relative effluent volumes calculated from plant flow records are summarized in Table 1. The relative effluent volumes were used to prepare the final composite sample, which was used to fill the sample container shipped to the laboratory for testing.

A 5-gallon cubitainers containing the composite sample was packed on ice in an ice chest for shipment to the laboratory. Sample chain of custody forms were completed and then sealed into zip-lock bags and taped inside the lid of the ice chest. Samples were shipped via DHL on flights from Pago Pago to Honolulu and then to San Francisco. Samples were delivered to the testing laboratory on 27 March 1994. Shipping and chain-of-custody are forms are provided as Attachment III.

Bioassay Testing Procedures

The bioassay tests were conducted by Advanced Biological Testing Inc., Tiburon, California. The testing procedures and results of the bioassay tests are provided "*Results of a Bioassay Conducted on an Effluent Sample from the Joint Cannery Outfall in American Samoa using Penaeus vannami and Mysidopsis bahia*" dated 24 April 1995 included as Attachment IV. This report summarizes the 96-hour acute bioassay test conducted with reference to the EPA document *EPA/600/4-90/027* as the source of methods for conducting the test.

The bioassay tests were conducted considering and following USEPA's comments on the October 1994 bioassay tests (Attachment I). As requested by USEPA, a brine control was run and a comparison was made with the dilution water "laboratory control". It was also requested that the age of the test organisms be 1 to 5 days old, with a 24-hour range in age and that test temperature be 20 ± 1 °C or 25 ± 1 °C. The mysids were 3-day old larvae tested at 25 ± 2 °C and the penaids were postlarvae (8 to 10 mm) tested at 20 ± 2 °C.

Because of the demonstrated potential for a lethal immediate dissolved oxygen demand (IDOD), discussed and documented in previous technical memoranda describing the first two bioassay tests, each bioassay test chamber was continuously aerated during the bioassay tests to maintain adequate levels of dissolved oxygen (DO). Bioassay tests were carried out for effluent concentrations of 50, 25, 12.5, 6.25, and 3.1% as vol:vol dilutions in seawater. Water quality was monitored daily with parameters measured including DO, pH, salinity, temperature, and ammonia. Additionally, a reference toxicant of sodium dodecyl sulfonate (SDS) was made up of a 2-gram per liter stock solution in distilled water and run at concentrations of 100, 50, 25, 12.5, and 6.25 mg/L in 31 ppt seawater for a 96-hour test.

Results

The results of the bioassay tests are summarized as follows:

Penaeus Vannami Effluent Bioassay. All results from the bioassay tests are included in Attachment IV. The results of the penaid bioassay tests indicate the LC_{50} for the effluent tested was 14.8 percent (95 percent confidence limits = 13.4 percent to 16.3 percent). The No Observable Effects Concentration (NOEC) for the 96-hour bioassay was 6.25 percent and the Least Observable Effects Concentration (LOEC) was 12.5 percent.

Penaeus Vannami Reference Toxicant Bioassay. The reference toxicant had a LC_{50} of 19.47 mg/l, a NOEC of 12.5 mg/l, an a LOEC of 25 mg/l.

***Mysidopsis Bahia* Effluent Bioassay.** All results from the bioassay tests are included in Attachment IV. The results of the mysid bioassay tests indicate the LC_{50} for the effluent tested was 10.8 percent (95 percent confidence limits = 9.5 percent to 12.3 percent). The No Observable Effects Concentration (NOEC) for the 96-hour bioassay was 6.25 percent and the Least Observable Effects Concentration (LOEC) was 12.5 percent.

***Mysidopsis Bahia* Reference Toxicant Bioassay.** The reference toxicant had a LC_{50} of 13.8 mg/l, a NOEC of 12.5 mg/l, an a LOEC of 25 mg/l.

Discussion

Table 2 summarizes the results of the effluent bioassay tests for the samples collected in the March 1995 sampling compared to the previous bioassay tests. The NOEC and LC_{50} are comparable to those obtained for the October 1993 and February 1994 penaid tests. The results are lower for the previous mysid test of October 1994. The results of this test suggest that the two species provide similar results when used in combined effluent bioassays.

Conclusions

The results of the bioassay tests for the Joint Cannery Outfall effluent are not considered to be of concern. As discussed in the reports for the previous tests on this effluent, the time scale of the mixing of the effluent with the receiving water is on the order of seconds to achieve dilutions that will eliminate possible toxic effects as reflected by the bioassay results. For example an NOEC of 1.6% corresponds to a dilution of 63:1, which is achieved in less than a minute and within about 30 feet of the discharge. The discharge is located in about 180 feet of water and the effluent is diluted to non-toxic levels within the initial dilution plume of the discharge.

Effluent Bioassay Testing
March 1995 Sampling
StarKist Samoa/VCS Samoa Packing

Table 1
StarKist Samoa and VCS Samoa Packing 24-hour Composite Sample
for Bioassay Testing
March 23-24, 1995

Grab Sample Number	VCS Samoa Packing		StarKist Samoa		VCS Samoa Packing Percent of Total Flow	StarKist Samoa Percent of Total Flow
	Sampling Time	Effluent Flow Rate (mgd)	Sampling Time	Effluent Flow Rate (mgd)		
1	0825	0.68	0838	1.37	4.2	8.5
2	1200	0.62	1130	1.62	3.9	10.1
3	1510	0.64	1450	1.26	4.0	7.9
4	1750	0.65	1745	1.33	4.0	8.3
5	2110	0.65	2050	1.40	4.0	8.7
6	0000	0.40	2350	1.30	2.5	8.1
7	0315	0.40	0300	1.37	2.5	8.5
8	0615	0.70	0550	1.66	4.4	10.3
Total		4.74		11.30	29.5	70.4
Mean		0.593		1.414		

Table 2
StarKist Samoa and VCS Samoa Packing
Combined Effluent Bioassay Results

Date	Parameters		
	LC_{50}	NOEC	LOEC
2/93 *Penaeus vannami*	4.8%[1]	3.1%	6.25%
10/93 *Penaeus vannami*	15.67%	3.1%	6.25%
2/94 *Penaeus vannami*	15.76%	<1.6%	1.6%
10/94 *Mysidopsis bahia*[2]	31.2%	25%	50%
3/95 *Penaeus vannami*	14.8%	6.25%	12.5%
3/95 *Mysidopsis bahia*[3]	10.8%	6.25%	12.5%

[1] The February 1993 samples were not aerated until after the first day of the test. For subsequent tests the samples were aerated for the entire duration of the tests.
[2] *Mysidopsis bahia* substituted as *Penaeus vannami* not available, as directed by U.S. EPA.
[3] *Mysidopsis bahia* used in addition to *Penaeus vannami* as described in text. Only one species is required by the permit conditions.

ATTACHMENT I

U.S. EPA MEMORANDUM:

Review of Joint Cannery Outfall Effluent Bioassay Testing Results
for October 1994
Memorandum from Amy Wagner date 17 February 1995

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX LABORATORY
1337 S. 46TH STREET BLDG 201
RICHMOND, CA 94804-4698

Febrary 17, 1995

SUBJECT: Review of Joint Cannery Outfall Effluent (DCN #OPIN011O95RJB1) and High Strength Waste Bioassay Testing (DCN #OPIN010O95RJB1) Reports

FROM: Amy L. Wagner (P-3-1) Amy Wagner 'Original Signed By'
Laboratory Section

THRU: Brenda Bettencourt, Chief (P-3-1) BBettencourt 'Original Signed By"
Laboratory Section

TO: Pat Young, E-4
OPINAP

I have reviewed the results from the reports entitled **Bioassay Testing of High Strength Waste: Starkist Samoa, Inc. and VCS Samoa Packing**, and **Joint Cannery Outfall Effluent Testing** from the October 1994 sampling. I have additional comments regarding the SOP for effluent sampling. The following items should be incorporated in the next testing period. If you have any questions, please feel free to call me at (510) 412-2329.

Laboratory Report of Bioassay Results for High Strength Waste Sampling

1. p. 9, Table 2. The salinity that the mysids were shipped in and any salinity acclimation before testing should be stated in the subsequent reports. The mysids should only experience a change in salinity of $\pm$ 2 ppt per day during acclimation.

2. Appendix Table 12. In the sanddab reference toxicant tests, unacceptably low levels of dissolved oxygen (D.O.) were measured. All test replicates with D.O. below 60% of saturation should be aerated.

Attachment II: Standard Operating Procedures Joint Cannery Outfall Effluent Sampling for Chemistry and Bioassay Toxicity Testing:

1. p. 5, #4: The procedure should also specify that each vial will be checked for air bubbles by slapping it inverted against the palm of the hand. If air bubbles can be seen, more sample should be added to the vial without overfilling.

2. p. 6, #3: A description of sample preservation and verification of pH should be included in this section. Only VOA vials should be preserved before sampling.

3. p. 6, #5: The packaging section should specify that sample jars should be wrapped in a minimum of 2 layers of bubble wrap for shipping.

4. Some general comments about health and safety protective gear (e.g., safety goggles, gloves) should be mentioned in the SOP.

Attachment IV: Laboratory Report, 96-hour Acute Bioassay, Joint Cannery Outfall Effluent Samples

1. p.2, Section 2.2, Sample Preparation: Since the tests were conducted using hypersaline brine to adjust effluent salinity, a brine control should have been conducted. Brine control and dilution water control results must be compared using a t-test at a p= 0.05 level.

2. p. 5, Table 1: An effort should be made to maintain the test conditions as specified in the test methods (EPA 600/4-90/027). The test method specifies that the age of test organisms should be 1-5 days old, with a 24 hour range in age, and the test temperature should be 20 $\pm$ 1° C or 25 $\pm$ 1 °C.

General Comments

1. I have been recently informed that penaeid shrimp in Hawaiian aquaculture facilities have been devastated due to a virus. Every attempt should be made to acquire penaeid shrimp, but if they are not available on the mainland for the spring 1995 testing, I again recommend that the laboratory use mysid shrimp, *Mysidopsis bahia*, as a surrogate species. As specified in the 10/14/94 memo, brine shrimp must be added to test containers daily and a water change using the original effluent sample should be conducted after 48 hours.

cc: Debra Denton, Whole Effluent Toxicity Coordinator (W-5-1)
Allan Ota, Wetlands and Sediment Management Section (W-3-3)
Steven Costa, CH_2M Hill
Kurt Kline, Advanced Biological Testing, Inc.

ATTACHMENT II

STANDARD OPERATING PROCEDURES (Revised)

JOINT CANNERY OUTFALL

EFFLUENT SAMPLING FOR CHEMISTRY

AND BIOASSAY TOXICITY TESTING

Standard Operating Procedures
Joint Cannery Outfall (JCO)
Effluent Sampling for Chemistry
and Bioassay Toxicity Testing

Introduction

StarKist Samoa, Inc. and VCS Samoa Packing are required by their NPDES permits to conduct semiannual priority pollutant analyses (effluent chemistry) and definitive acute bioassays on their cannery effluent. The following gives detailed procedures for collecting and preparing effluent samples for these analyses. The effluent chemistry and bioassay analyses are to be conducted simultaneously, therefore, this standard operating procedure (SOP) addresses collection of samples for both of these tests as a single procedure. At this time the chemical analysis are done on each cannery separately and the bioassay test is done on a combined composite from each cannery.

Overview

The following cannery effluent samples must be collected and prepared for shipment to the appropriate laboratory:

- Composite samples of cannery effluent from the StarKist Samoa, Inc. facility for chemical analysis
- Composite samples of cannery effluent from the VCS Samoa Packing facility for chemical analysis
- A composite sample of combined effluent from both StarKist Samoa, Inc. and VCS Samoa Packing for acute bioassay tests

Each of the effluent chemistry samples will be a composite of 8 grab samples taken over a 24 hour period. The bioassay sample will be a composite of 16 grab samples, 8 from StarKist Samoa, Inc. and 8 from VCS Samoa Packing, collected over the same 24 hour period.

Sampling requires a coordinated effort by both canneries. The canneries should conduct their sampling so that samples are collected on approximately the same schedules. The sampling must be scheduled so that the samples are composited the day they are shipped to laboratories for analysis. An example schedule is shown in Table 1.

Table 1 Example Schedule for Sample Collection	
Time	Activity
Wednesday 12:00 noon - Thursday 9:00 am	Collect grab samples from both canneries for chemistry and bioassay tests
Thursday 9:00 am - 12:00 noon	Composite samples in cannery laboratory
Thursday 1:00 pm - 3:00 pm	Prepare samples for shipping
Thursday 4:00 pm	Deliver coolers containing samples to the airport

The above example schedule assumes samples are shipped on a Thursday evening flight (note that flight schedules often change and the sampling should be scheduled to minimize holding times). The above schedule shall be modified based on the availability of laboratory personnel and airline schedules, however, the samples should be composited on the day of the scheduled flight and sampling should take place during the 24 hours just before compositing the samples. The only exception is a weekend shipment, where samples should always be collected after 12 noon on Monday and before 12 noon on Friday.

Special Note

Beginning with the March 1994 sampling, volatile organics, pesticides/PCBs, and cyanide will not be analyzed as approved by USEPA Region IX. The procedures for these samples are described below since sampling may resume in the future. At this time these samples will not be collected and shipped. Text associated with these constituents is shown in redline as illustrated here.

List of Equipment/Supplies

The following supplies will be required for collecting effluent samples, compositing the samples, and preparing them for delivery to the laboratories: (note: items marked with an asterisk (*) will be supplied by CH2M HILL or by the laboratory performing the analyses)

Sample Collection (required per facility)

- * Eight (8) 1-liter sampling jars
- * Eight (8) 1-gallon cubitainers or other appropriate containers
- * Eight (8) 40 ml VOA vials for sampling volatiles (supplied as part of chemistry kit listed below)
- Labels and permanent marker for marking sample containers
- * Ice chests with ice (or refrigerator space) for storing samples (There should be sufficient storage space for storing all containers listed above)

Compositing and shipping samples

- * Chemistry kit (one for each cannery)
  (cooler + containers, see contents listed in Table 2)
- Clean graduated cylinder(s) for compositing effluent samples (suggest 1000 ml cylinder for bioassay composites, 100 - 200 ml cylinder for chemistry composites)
- Labels and permanent marker for identifying samples
- * An additional large cooler for bioassay composites
- Cubed ice (two bags per cooler)
- * Large or Extra Large zip-lock/freezer bags
- * Compositing worksheets (Attachments A and B)
- Calculator
- * Chain of Custody Forms

Sampling

Eight samples will be collected at each cannery over a 24-hour period. The samples should be collected from normal accepted sampling locations at which the flow rate is known. Samples shall be collected at intervals of approximately three hours. Two VOA samples will be collected at each cannery at intervals of approximately 6 hours (i.e. every second sample).

The general procedure for collecting samples is outlined below:

1) Label a 1-liter sampling jar and a 1-gallon container with sample number to be collected, time of sample collection, and flow rate during sampling. Labelling should be done with a permanent marker on a waterproof label. Plastic containers may be written on directly. Every second sampling event (6-hour intervals) label two 40 ml VOA vials. The labels on the VOA vials will be used to identify the samples by the lab and should be descriptive of the samples.

The convention used for labeling samples should identify the facility in the first part of the label (SK = StarKist Samoa, VCS = VCS Samoa Packing) and the type of analysis in the second (VOL = volatiles). A similar convention should be used for labeling the samples with an extension to indicate the sample number and bottle. For example, SK-VOL-1a and SK-VOL-1b would identify the two vials filled during the first sample collection at the StarKist cannery. Each sample bottle should be labeled with time and date as well.

Write down the date, time, and flow rate on the appropriate row in columns A, B, and C of the Worksheet for Compositing Effluent Chemistry Samples (Attachment A).

Table 2
Contents of Effluent Chemistry Kits
(one for each cannery)

Sample Container	Qty	Chemical Parameter	Sample Preservative
40 ml vial	8	Volatile Organics	HCL
40 ml vial	2	Volatile Organic Trip Blanks	HCL
1-liter amber glass	1	Semivolatile Organics	none
1-liter amber glass	1	Pesticides/PCB's	none
500 ml plastic	1	Phenols	H_2SO_4
500 ml plastic	1	Total Cyanide	NaOH
500 ml plastic	1	Inorganics/Metals	HNO_3

2) **Chemistry Sample.** Rinse a 1-liter sampling jar out with effluent. Fill jar to the top and cover securely with its lid. If samples are collected from a tap in the line, fill the sample container directly from the tap. If samples are collected from a flume requiring the container to be dipped under the surface, use a separate container to remove the effluent from the flume and fill the sample container. Any container used for sampling should be clean and rinsed with effluent prior to collecting each sample.

3) **Bioassay Sample.** Collect the bioassay sample in the 1 gallon sampling container in the same manner as the chemistry sample. Rinse the 1 gallon container and any other sampling container used with effluent prior to filling.

4) **VOA Samples.** (Every 6 hours) Fill two VOA vials to the top with effluent. DO NOT rinse vials prior to filling them. These bottles contain a preservative that should not be rinsed out. Make every effort to fill each to the top so there is no airspace when the vial is capped. Outgassing of the warm effluent may occur resulting in an air bubble. If this happens, note this on the compositing worksheet. Each vial should be checked for air bubbles by slapping it inverted against the palm of the hand. If air bubbles can be seen, more sample should be added to the vial without overfilling.

5) Store all samples in coolers on ice or refrigerator at a temperature of approximately 4 °C. Do **NOT** store samples in a freezer or by using a method that would freeze the sample.

Sample Preparation/Compositing

The samples will be composited in the StarKist Samoa and/or VCS Samoa Packing laboratories. The effluent chemistry samples from each cannery can be composited and prepared separately in each facility's lab. The bioassay samples must be composited together and all bioassay samples will need to be delivered to one lab or the other. The area used for compositing should include a sink and clear tabletop area that is clean and dry. Basic steps used to composite the effluent chemistry and bioassay samples are listed below. Worksheets for calculating composite volumes are included as Attachments A and B. Example completed forms, including worksheets for chemical and bioassay composite sample preparation and chain-of-custody forms are included as Attachment C.

Effluent Chemistry

1) **Label Containers.** If this has not already been done by the laboratory, the containers listed in Table 2 (with the exception of the VOA vials which should be filled with effluent and stored in a cooler or refrigerator) should be labeled and placed on the table. The labels will be used to identify the samples by the lab and should be descriptive of the samples. These will also be used on the chain-of-custody forms that will be attached to each cooler. An example chain-of-custody form is included in Attachment C. The convention used for these samples identifies the facility in the first part of the label (SK = StarKist Samoa, VCS = VCS Samoa Packing) and the

type of analysis in the second (M = metals, SV = semi-volatiles, PEST = pesticides/PCBs, CN = cyanide, PH = phenols, and VOL = volatiles). This or a similar convention shall be used for labeling the samples.

2) **Calculate Composite Volumes.** The worksheet included as Attachment A should be used to calculate volumes of each of the eight individual samples that will be required to be composited into single samples for laboratory analysis. Columns A through C should be filled out during the sample collection. Instructions for filling out the remainder of the table are included on the worksheet. Column D in the worksheet represents the fraction of the composited sample that should come from the individual sample represented by that row. Columns E and F give the volume of each individual sample that is required to produce 1 liter and 500 ml samples, respectively. The bottom row of the table, labeled "Totals:", are totals from the columns above them. The box labeled TF is used to calculate the numbers in column D. The other boxes are used to check arithmetic and should be equal to the numbers in parenthesis below them.

3) **Composite Samples.** Volumes calculated in Column E of the worksheet should be used to composite samples into 1 liter jars. Similarly, volumes calculated in Column F should be used for 500 ml composite samples. A clean graduated cylinder should be used to measure the effluent. Prior to compositing the samples, the cylinder should be rinsed with a dilute solution of nitric acid (HNO_3), rinsed out with de-ionized or distilled water, and finally rinsed with effluent.

   Chemistry sample containers listed in Table 2 (excluding VOA vials) should be filled using the graduated cylinder to measure the appropriate volumes of each individual sample. The container lids should then be securely tightened onto the sample containers. Note that all sample containers to be shipped to the laboratory for chemical analysis have been prepared in the laboratory and the correct amount and type of preservative is in each bottle.

4) **Complete Chain of Custody Form(s).** A package including chain-of-custody forms will be included with the containers. At least one chain-of-custody form is required for each cooler of samples that will be shipped. An example of a completed chain-of-custody form is included as part of Attachment C. Sample identification on the chain-of-custody should match the labels on the sample containers exactly. VCS Samoa Packing and StarKist Samoa effluent chemistry samples should be shipped in separate coolers.

5) **Package Samples for Shipping.** Each sample jar should be wrapped in bubble-wrap or an equivalent packaging material and placed in a plastic zip-

lock bag. Glass container should be wrapped in two layers of bubble-wrap at a minimum. As much air as possible should be removed from the bag prior to sealing it. Too much air inside the bags will expand during the flight and pop the bag open. All chemistry samples from one cannery should be packaged in a single cooler if possible. Place sample jars inside the cooler. Packaging material (bubble wrap or equivalent) should be placed in the cooler to prevent containers from moving and impacting each other.

Ice or an equivalent means (such as chemical cold packs) must be included to keep the samples cold during shipping. Do not use dry ice to pack the samples. If ice is used, precautions should be taken to prevent melted ice from leaking out of the cooler during shipping. These include taping any drain plugs in the cooler shut with duct tape or strapping tape, and "double-bagging" the ice cubes in zip-lock bags, i.e. sealing the ice cubes in one bag, then sealing the bag containing ice in a second bag. As with the bags used to hold the sample jars, as much air as possible should be removed from the bags prior to sealing.

The chain-of-custody form for each cooler should be signed, placed in a zip-lock bag, and taped with duct tape to the inside of the cooler lid. The cooler should be taped securely shut with strapping tape or other strong packaging tape to prevent it from opening during shipping.

6) **Shipping.** Ship the chemistry samples to the laboratory as directed for each sampling period. For the October 1994 sampling ship the chemistry samples to:

Mr. Bill Svoboda
GTEL Environmental Laboratory
480 Pike Lane
Concord, CA 94520
(510) 685-7852 Phone
(510) 825-0720 Fax

Or to the person and laboratory as directed by the project manager, if different from above.

Effluent Bioassay

1) **Calculate Composite Volumes.** The worksheet included as Attachment B should be used to calculate volumes of each of the 16 individual samples that will be required to be composited into the 2 1/2-gallon cubitainer. Columns A and B should be filled out based on the flows recorded during sampling onto the effluent chemistry compositing worksheet. Note that

flows must be recorded in million gallons per day (mgd). If flows are greater than about 2, they are probably recorded in gallons per minute (gpm). If flows are reported in gpm they should be converted by multiplying the recorded flow by 0.0014. Instructions for filling out the remainder of the table are included on the worksheet. Columns C and D in the worksheet represent the fraction of the composited sample that should come from individual samples taken at each cannery. Columns E and F give the volume of each individual sample that is required to produce a 2 1/2-gallon composited sample, the individual volumes must be adjusted for an alternative volume. The bottom row of the table, labeled "Totals:", are totals from the columns above them. The box labeled TF is used to calculate the numbers in columns C and D. The other boxes are used to check arithmetic and should be equal to the numbers in parenthesis below them.

On special instruction from the laboratory the volume required may change. Always check with the laboratory prior to initiating sampling, since the volume required for individual grab samples will need to be modified if the required size of the composite sample is increased. <u>For the March 1995 sampling a 5-gallon sample is required because two organisms are to be tested.</u>

3) **Composite Samples.** Volumes calculated in Columns E and F of the worksheet should be used to create 2 1/2-gallon (or alternative volume) composite sample. A clean graduated cylinder should be used to measure the effluent. Prior to compositing the samples, the cylinder should be rinsed with a dilute solution of nitric acid (HNO_3), rinsed out with de-ionized or distilled water, and finally rinsed with effluent from one of the samples.

   The cubitainer holding the sample should be clearly marked as "JCO Effluent Bioassay Sample." The graduated cylinder should be used to fill the cubitainer with the appropriate volumes from each of the 16 sample containers. Excess air should be squeezed out of the container prior to capping it.

4) **Complete Chain of Custody Form.** A package including chain-of-custody forms will be included with the effluent chemistry sample containers. One chain-of-custody form is required the composite bioassay sample. An example of a completed chain-of-custody form is included as part of Attachment C.

5) **Package Sample for Shipping.** The cubitainer holding the bioassay sample should be placed in a dedicated cooler. The bioassay and effluent chemistry

samples described above will be sent to separate labs. Therefore, these should not be packaged together. Ice or an equivalent means (such as chemical cold packs) should be used to fill in the empty space in the cooler and keep the samples cold during shipping. If ice is used, precautions should be taken to prevent the melted ice from leaking out of the cooler during shipping. These include taping any drain plugs in the cooler shut with duct tape or strapping tape, and "double-bagging" the ice cubes in zip-lock bags, i.e. sealing the ice cubes in one bag, then sealing the bag containing ice in a second bag. As described for the effluent chemistry samples described above, as much air as possible should be removed from the bags prior to sealing.

The chain-of-custody form should signed, placed in a zip-lock bag, and taped with duct tape to the inside of the cooler lid. The cooler should be taped securely with strapping tape or other strong packaging tape to prevent it from opening during shipping.

6) **Shipping.** Ship the bioassay sample to the laboratory as directed for each sampling. For the October 1994 sampling ship the bioassay sample to:

Dr. Kurt Kline
Advanced Biological Testing, Inc.
3150 Paradise Drive
Building 50
Tiburon, CA 94920
(415) 435-7878 phone
(415) 435-7882 Fax

Health and Safety Considerations

The sample collection and compositing should be done or directly supervised by staff that are experienced with this type of work and are fully aware of all health and safety practices that apply in such cases. The canneries will require that all staff in the facility wear long pants and closed shoes (no sandals). In addition cannery personnel will brief project staff on evacuation routes and other safety issues as required. Head and hearing protection must be available and worn in designated areas while in the canneries and cannery personnel will provide project staff with hats and ear plugs. While collecting samples from the effluent flumes, gloves and appropriate eye protection must be worn. Floors, decks, and ladders are often slippery and shoes with appropriate sole material should be selected for work in the canneries.

The above description is not intended to be comprehensive or exhaustive. Always work with experienced staff and when in doubt ask cannery personnel about correct policies and procedures.

Attachment A
Worksheet for Compositing Effluent Chemical Samples

Facility: Date:

Worksheet for Compositing Effluent Chemistry Samples						
No.	Sample Collection Time		(C) Flow	(D) Fraction of Total Flow	Volume of sample (ml)	
	(A) Date	(B) Time			(E) 1 liter container	(F) 500 ml container
1						
2						
3						
4						
5						
6						
7						
8						
		Totals:				
			(TF)	(1.0)	(1000 ml)	(500 ml)

Instructions:

1) Fill in date and time each sample was taken (columns A and B) and recorded flow rate at the time of the sample (column C).

2) Add all flows and record in box below column C (TF)

3) Calculate fraction of total flow (column D) for each flow rate in column C:

   Fraction of total (D) = Flow (C) ÷ Total flow (TF)

4) Calculate volume of collected sample for 1-liter and 500 ml chemistry sample containers (columns E and F):

   (E) = (D) x 1000
   (F) = (D) x 500

5) Check calculations. Sum columns D, E, and F and record totals in boxes below each column. Numbers should match numbers in parenthesis below the boxes.

Attachment B
Worksheet for Compositing Effluent Bioassay Samples

Facility: Date:

Worksheet for Compositing Effluent Bioassay Samples						
No.	(A) VCS Flow (mgd)	(B) SKS Flow (mgd)	Fraction of Total Flow		Volume of sample for 2 1/2 gal container (ml)	
			(C) VCS (A)÷(TF)	(D) SKS (B)÷(TF)	(E) VCS (C)x9500	(F) SKS (D)x9500
1						
2						
3						
4						
5						
6						
7						
8						
Totals:						
	Total (A)+(B):		Total (C)+(D):		Total (E)+(F):	
		(TF)		(1.0)		(9500 ml)

Instructions:

1) Fill in recorded flow rates in columns A and B. Flow rates should be in mgd. (Note: StarKist flowrates may be in gpm. If flows are greater than about 2, they are probably measured as gpm. To convert, multiply the flow recorded in gpm by 0.0014).

2) Total flows for VCS and SKS in columns A and B. Sum the totals and write total in box labeled (TF).

3) Calculate fraction of total flow for each sample (columns C and D). To check calculations, total columns C and D and add totals together in box at bottom of column D. Total should equal 1.0

4) Calculate volume required of each collected sample to fill a 2 1/2-gallon container (columns E and F):

   (E) = (C) x 9500
   (F) = (D) x 9500

   For an alternative volume the constant must be adjusted, for example for a 5-gallon container:

   (E) = (C) x 19000
   (F) = (D) x 19000

5) Check by totaling columns E and F. Sum of E + F should equal approximately 9500 for a 2 1/2 gallon container.

Attachment B

Attachment C
Example Worksheet and Chain-of-Custody Forms

Facility: StarKist Samoa Date: 2/16/94

Worksheet for Compositing Effluent Chemistry Samples						
No.	Sample Collection Time		(C) Flow *(gpm)*	(D) Fraction of Total Flow	Volume of sample (ml)	
	(A) Date	(B) Time			(E) 1 liter container	(F) 500 ml container
1	2/15	1000	1025	0.154	154	77
2		1300	800	0.120	120	60
3		1600	900	0.135	135	68
4		1900	775	0.116	116	58
5		2200	800	0.120	120	60
6	2/16	0100	775	0.116	116	58
7		0400	850	0.127	127	63
8		0700	750	0.112	112	56
		Totals:	6675	1.000	1000	500
			(TF)	(1.0)	(1000 ml)	(500 ml)

Instructions:

1) Fill in date and time each sample was taken (columns A and B) and recorded flow rate at the time of the sample (column C).

2) Add all flows and record in box below column C (TF)

3) Calculate fraction of total flow (column D) for each flow rate in column C:

   Fraction of total (D) = Flow (C) ÷ Total flow (TF)

4) Calculate volume of collected sample for 1-liter and 500 ml chemistry sample containers (columns E and F):
   (E) = (D) x 1000
   (F) = (D) x 500

5) Check calculations. Sum columns D, E, and F and record totals in boxes below each column. Numbers should match numbers in parenthesis below the boxes.

Facility: JCO, StarKist and VCS Samoa Packing Date: 2/16/94

Worksheet for Compositing Effluent Bioassay Samples						
No.	(A) VCS Flow (mgd)	(B) SKS Flow (mgd)	Fraction of Total Flow		Volume of sample for 2 1/2-gal container (ml)	
			(C) VCS (A)÷(TF)	(D) SKS (B)÷(TF)	(E) VCS (C)x9500	(F) SKS (D)x9500
1	0.26	1.48	0.018	0.102	171	969
2	0.6	1.15	0.041	0.079	390	751
3	0.64	1.3	0.044	0.090	418	855
4	0.64	1.12	0.044	0.077	418	732
5	0.64	1.15	0.044	0.079	418	751
6	0.68	1.12	0.047	0.077	447	732
7	0.68	1.22	0.047	0.084	447	798
8	0.72	1.08	0.050	0.075	475	713
Totals:	4.86	9.62	0.335	0.663	3184	6301
	Total (A)+(B):	14.48	Total (C)+(D):	0.998	Total (E)+(F):	9485
		(TF)		(1.0)		(9500 ml)

Instructions:

1) Fill in recorded flow rates in columns A and B. Flow rates should be in mgd. (Note: StarKist flowrates may be in gpm. If flows are greater than 10, they are probably measured as gpm. To convert, multiply the flow recorded in gpm by 0.0014).

2) Total flows for VCS and SKS in columns A and B. Sum the totals and write total in box labeled (TF).

3) Calculate fraction of total flow for each sample (columns C and D). To check calculations, total columns C and D and add totals together in box at bottom of column D. Total should equal 1.0

4) Calculate volume required of each collected sample to fill a 2 1/2-gallon container (columns E and F):

   (E) = (C) x 9500

   (F) = (D) x 9500

   See Attachment B for the adjustment required for a different size container.

5) Check by totaling columns E and F. Sum of E + F should equal approximately 9500 for a 2 1/2 gallon container.

Attachment C

— EXAMPLE —

CH2M HILL QUALITY ANALYTICAL LABORATORIES

CHAIN OF CUSTODY RECORD AND AGREEMENT TO PERFORM SERVICES

CH2M HILL Project #	OPE38782.EL.JA
Purchase Order #	
Project Name	JCO EFFLUENT COMPOSITE BIOASSAY
Company Name/CH2M HILL Office	CH2M HILL / SFO
Project Manager & Phone #	Mr. [ ] Ms. [ ] Dr. [X] STEVE COSTA 510 251-2888 x2251
Report Copy to:	SAME
Requested Completion Date:	A.S.A.P.
Sampling Requirements	SDWA [ ] NPDES [X] RCRA [ ] OTHER ____
Sample Disposal:	Dispose [X] Return [ ]

LAB TEST CODES

SHADED AREA – FOR LAB USE ONLY: Lab 1 # / Lab 2 # / Quote # / Kit Request # / Project # / No. of Samples / Page / of / COC Rev / Login / LIMS Ver / Ack Gen

ANALYSES REQUESTED: BIOASSAY (ADVANCED BIOLOGICAL TESTING INC)

Sampling '94 Date	Time	Type COMP	Type GRAB	Matrix WATER	Matrix SOIL	CLIENT SAMPLE ID (9 CHARACTERS)	# OF CONTAINERS	BIOASSAY (ADVANCED BIOLOGICAL TESTING INC)	REMARKS	LAB 1 ID	LAB 2 ID
10/27	1300	X		X		JCO-EFF	1	X	1-2½ gal cubitainer flow composite		

EXAMPLE

Sampled By & Title (Please sign and print name)	Helen Pena HELEN PENA	Date/Time	10/27 1300
Received By (Please sign and print name)		Date/Time	
Received By (Please sign and print name)		Date/Time	
Received By (Please sign and print name)		Date/Time	
Work Authorized By (Please sign and print name)		Remarks	SAMPLE is A 24 hr. flow composite started at 10/26/94 at 12NOON SENT TO: ADVANCED BIOLOGICAL TESTING, INC.

Relinquished By (Please sign and print name)		Date/Time
Relinquished By (Please sign and print name)		Date/Time
Relinquished By (Please sign and print name)		Date/Time
Shipped Via: UPS BUS Fed-Ex Hand Other____		Shipping #

HAZWRAP/NESSA: Y N
QC Level: 1 2 3 Other: ____
COC Rec | ICE
Ana Req | TEMP
Cust Seal | Ph

Instructions and Agreement Provisions on Reverse Side

DISTRIBUTION: ORIGINAL - LAB, Yellow - LAB, Pink - Client

REV 11/92 FORM 340

CH2M HILL

QUALITY ANALYTICAL LABORATORIES

CHAIN OF CUSTODY RECORD AND AGREEMENT TO PERFORM SERVICES

— SAMPLE —

CH2M HILL Project #	0PE307Ø2.EL.J4
Purchase Order #	
Project Name	STARKIST EFFLUENT CHEMICAL ANALYSIS
Company Name/CH2M HILL Office	CH2M HILL / SFO
Project Manager & Phone #	Mr. [ ] STEVE COSTA Ms. [ ] Dr. [X] (510) 251-2888 X2251
Report Copy to:	SAME
Requested Completion Date:	A.S.A.P
Sampling Requirements	SDWA [ ] NPDES [X] RCRA [ ] OTHER [ ]
Sample Disposal:	Dispose [X] Return [ ]

Sampling Date	Sampling Time	Type COMP	Type GRAB	Matrix WATER	Matrix SOIL	CLIENT SAMPLE ID (9 CHARACTERS)	# OF CONTAINERS	VOLATILE ORGANICS (VOL)	SEMIVOLATILE ORGANICS (SV)	PESTICIDES/PCB'S (PEST)	PHENOLS (PH)	TOTAL CYANIDE (CN)	INORGANICS/METALS (M)	VOLATILE ORGANICS TRIP BLANKS (VOL)	REMARKS
10/26	1200		X	X		STARKIST	2	X		D					40 ml vial w/HCl
	1800		X	X		STARKIST	2	X							40 ml vial w/HCl
	2400		X	X		STARKIST	2	X							40 ml vial w/HCl
10/27	0600		X	X		STARKIST	2	X							40 ml vial w/HCl
10/27	1200	X		X		STARKIST	1		X						liter amber glass
		X		X		STARKIST	1			X					liter amber glass
		X		X		STARKIST	1				X				500 ml plastic w/H_2SO_4
		X		X		STARKIST	1					X			500 ml plastic w/NaOH
		X		X		STARKIST	1						X		500 ml plastic w/HNO_3
—	—	—	—	—	—	STARKIST	2							X	40 ml vial w/HCl H_2O

LAB TEST CODES

SHADED AREA – FOR LAB USE ONLY

Lab 1 #	Lab 2 #
Quote #	Kit Request #
Project #	
No. of Samples	Page / of
COC Rev / LogIn	LIMS Ver / Ack Gen

Sampled By & Title	Helen Pena (Please sign and print name) HELEN PENA	Date/Time 10/27 1200
Received By	(Please sign and print name)	Date/Time
Received By	(Please sign and print name)	Date/Time
Received By	(Please sign and print name)	Date/Time
Work Authorized By	(Please sign and print name)	

Relinquished By	(Please sign and print name)	Date/Time
Relinquished By	(Please sign and print name)	Date/Time
Relinquished By	(Please sign and print name)	Date/Time
Shipped Via	UPS BUS Fed-Ex Hand Other	Shipping #
Remarks	VOLATILE ORGANIC GRAB SAMPLES TO BE COMPOSITED AT GTEL ENVIRONMENTAL LABORATORY	

HAZWRAP/NESSA: Y N

QC Level: 1 2 3 Other:

COC Rec	ICE
Ana Req	TEMP
Cust Seal	Ph

Instructions and Agreement Provisions on Reverse Side

DISTRIBUTION: ORIGINAL - LAB, Yellow - LAB, Pink - Client

REV 11/92 FORM 340

SAMPLE

CH2M HILL

QUALITY ANALYTICAL LABORATORIES

CHAIN OF CUSTODY RECORD AND AGREEMENT TO PERFORM SERVICES

CH2M HILL Project #	0PE30702.EL.J4
Purchase Order #	
Project Name	VCS SAMOA PACKING EFFLUENT CHEMICAL ANALYSIS
Company Name/CH2M HILL Office	CH2M HILL / SFO
Project Manager & Phone #	Mr. [ ] Ms. [ ] Dr. [X] STEVE COSTA (510) 251-2888 x225
Report Copy to:	SAME
Requested Completion Date:	A.S.A.P.
Sampling Requirements	SDWA [ ] NPDES [X] RCRA [ ] OTHER ____
Sample Disposal:	Dispose [X] Return [ ]

LAB TEST CODES

SHADED AREA – FOR LAB USE ONLY

Lab 1 #	Lab 2 #
Quote #	Kit Request #
Project #	
No. of Samples	Page ___ of ___
COC Rev	Login
LIMS Ver	Ack Gen

ANALYSES REQUESTED

Sampling 94 Date	Time	Type COMP	Type GRAB	Matrix WATER	Matrix SOIL	CLIENT SAMPLE ID (9 CHARACTERS)	# OF CONTAINERS	VOLATILE ORGANICS (VOL)	SEMI VOLATILE ORGANICS (SV)	PESTICIDES / PCB'S (PEST)	PHENOLS (PH)	TOTAL CYANIDE (CN)	INORGANICS / METALS (M)	VOLATILE ORGANICS TRIP BLANKS (VOL)	REMARKS	LAB 1 ID	LAB 2 ID
10/26	1230		X	X		VCS-SAMOA	2	X							40 ml vial w/HCL		
	1830		X	X		VCS-SAMOA	2	X							40 ml vial w/HCL		
	2430		X	X		VCS-SAMOA	2	X							40 ml vial w/HCL		
10/27	0630		X	X		VCS-SAMOA	2	X							40 ml vial w/HCL		
10/27	1300	X		X		VCS-SAMOA	2		X						1 liter amber glass		
↓	↓	X		X		VCS-SAMOA	1			X					1 liter amber glass		
		X		X		VCS-SAMOA	1				X				500 ml plastic w/H_2SO_4		
		X		X		VCS-SAMOA	1					X			500 ml plastic w/NaOH		
↓	↓	X		X		VCS-SAMOA	1						X		500 ml plastic w/HNO_3		
—	—	*		*		VCS-SAMOA	2							X	40 ml vial w/HCL H_2O		

SAMPLE

Sampled By & Title (Please sign and print name) Barry Fowler / BARRY FOWLER	Date/Time 10/27/ 1300	Relinquished By (Please sign and print name)	Date/Time	HAZWRAP/NESSA: Y N
Received By (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name)	Date/Time	QC Level: 1 2 3 Other: ____
Received By (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name)	Date/Time	COC Rec / ICE; Ana Req / TEMP; Cust Seal / Ph
Received By (Please sign and print name)	Date/Time	Shipped Via UPS BUS Fed-Ex Hand Other____		Shipping #
Work Authorized By (Please sign and print name)	Remarks VOLATILE organic GRAB SAMPLES TO BE COMPOSITED IN LABORATORY (GTEL ENVIRONMENTAL LAB)			

Instructions and Agreement Provisions on Reverse Side

DISTRIBUTION: ORIGINAL - LAB, Yellow - LAB, Pink - Client

REV 11/92 FORM 340

CH2M HILL

QUALITY ANALYTICAL LABORATORIES

CHAIN OF CUSTODY RECORD AND AGREEMENT TO PERFORM SERVICES

CH2M HILL Project # ☐☐☐☐☐☐☐.☐☐.☐☐ | Purchase Order #

Project Name

Company Name/CH2M HILL Office

Project Manager & Phone #
Mr. [ ]
Ms. [ ]
Dr. [ ]

Report Copy to:

Requested Completion Date:

Sampling Requirements: SDWA ☐ NPDES ☐ RCRA ☐ OTHER ____

Sample Disposal: Dispose ☐ Return ☐

Sampling Date	Sampling Time	Type COMP	Type GRAB	Matrix WATER	Matrix SOIL	CLIENT SAMPLE ID (9 CHARACTERS)	# OF CONTAINERS	LAB TEST CODES / ANALYSES REQUESTED

SHADED AREA – FOR LAB USE ONLY

Lab 1 # | Lab 2 #

Quote # | Kit Request #

Project #

No. of Samples | Page | of

COC Rev | LogIn | LIMS Ver | Ack Gen

REMARKS | LAB 1 ID | LAB 2 ID

Sampled By & Title (Please sign and print name) | Date/Time

Relinquished By (Please sign and print name) | Date/Time

Received By (Please sign and print name) | Date/Time

Relinquished By (Please sign and print name) | Date/Time

Received By (Please sign and print name) | Date/Time

Relinquished By (Please sign and print name) | Date/Time

Received By (Please sign and print name) | Date/Time

Shipped Via: UPS BUS Fed-Ex Hand Other____ | Shipping #

Work Authorized By (Please sign and print name)

Remarks

HAZWRAP/NESSA: Y N

QC Level: 1 2 3 Other: ____

COC Rec | ICE

Ana Req | TEMP

Cust Seal | Ph

Instructions and Agreement Provisions on Reverse Side

DISTRIBUTION: ORIGINAL - LAB, Yellow - LAB, Pink - Client

REV 11/92 FORM 340

ATTACHMENT III

SAMPLE SHIPPING AND CHAIN OF CUSTODY FORMS

JOINT CANNERY OUTFALL EFFLUENT SAMPLES
March 23-24, 1995

DHL WORLDWIDE EXPRESS

INSTRUCTIONS
1. Type or print firmly
2. Complete applicable unshaded areas
3. Instructions in full on reverse
4. Call us if you have any questions

1 SHIPPER'S ACCOUNT No.	2 SHIPPER'S REFERENCE
921130590	OPE30702.EL.T5

5300109 13

FORWARDER AIRBILL - NON NEGOTIABLE

ORIGIN	DESTINATION
HG.	NSB
3 PIECES	WEIGHT
1	56

4 SENT BY (COMPANY NAME)

CHZM HILL
STEVE COSTA
1111 BROADWAY
OAKLAND, CA USA
94607 510-251-2426

5 RECIPIENT (COMPANY NAME)

ADVANCED BIOLOGICAL TSTNG
DR. KURT KLINE - BLDG 50
3150 PARADISE DRIVE
TIBURON, CA ~~94920~~ USA
94920 415-435-7878

6 SERVICES / CHARGES

- DOCUMENT ☐ EXPRESS DOCUMENT ☐
- WORLDWIDE PACKAGE EXPRESS ☒ (INTERNATIONAL DUTIABLE)
- WORLDMAIL ☐ 1st CLASS ☐ 2nd CLASS
- SATURDAY SERVICE ☐
- INSURANCE Enter amount ☐ YES ☐ NO
- PROOF OF DELIVERY ☐ (POD)
- OTHER ☐
- ONFORWARDING ☐
- EXPRESS CENTER DROP BOX ☐

TOTAL

7 DESCRIPTION OF CONTENTS

WATER SAMPLES FOR TESTING

DIMENSIONS | DIMENSIONAL/CHARGED WEIGHT

10 METHOD OF PAYMENT

Assumed to be sender unless otherwise specified

- ☐ BILL RECIPIENT
- ☐ 3rd Party ACCOUNT NUMBER
- ☐ CASH $ CHECK No.
- ☐ CHECK $
- ☐ CREDIT CARD

8 COMPLETE FOR WORLDWIDE PACKAGE EXPRESS (INTERNATIONAL DUTIABLE SHIPMENTS)

DECLARED VALUE FOR CUSTOMS (SPECIFY CURRENCY): Ø

COMMODITY/TARIFF CODE

SHIPPER'S EIN/SSN OR VAT NUMBER

EXPORT LICENSE NUMBER/SYMBOL

THIS SHIPMENT LICENSED BY THE UNITED STATES FOR ULTIMATE DESTINATION. DIVERSION CONTRARY TO U.S. LAW PROHIBITED. IF ULTIMATE DESTINATION IS SOUTH AFRICA OR NAMIBIA, RESALE TO OR DELIVERY, DIRECTLY OR INDIRECTLY, TO OR FOR USE BY OR FOR POLICE OR MILITARY ENTITIES PROHIBITED.

IMPORT CHARGES: DUTY / OTHER

9 CHARGE TO: ☐ RECEIVER ☐ SHIPPER

DHL'S TERMS AND CONDITIONS OF CARRIAGE

11 WE DO HEREBY AUTHORIZE DHL TO EXECUTE ANY ADDITIONAL DOCUMENTS NECESSARY FOR THE EXPORT OF MERCHANDISE DESCRIBED HEREIN ON MY/OUR BEHALF. DHL DOES NOT CARRY CASH.

SHIPPER'S SIGNATURE [signature] DATE 3/24/95

PICKED UP BY DHL

DATE 3/24/95 TIME 5:00 PM

SHIPPER'S COPY

ONE SOFTWARE INC. Form 7886 (REV. 1/96) • 333 TWIN DOLPHIN DRIVE, REDWOOD CITY, CA 94065 007190

CH2M HILL

APPLIED SCIENCES LABORATORY

CHAIN OF CUSTODY RECORD AND AGREEMENT TO PERFORM SERVICES

CH2M Hill Project #: QPE30702ELL5

Purchase Order #:

Project Name: JOINT CANNERY OUTFALL

Company Name/CH2M HILL Office:

Project Manager & Phone #: Mr. [ ] Ms. [ ] Dr. [X] STEVE COSTA 510-251-2426

Report Copy to: SAME

Requested Completion Date:

Sampling Requirements: SDWA [ ] NPDES [X] RCRA [ ] OTHER [ ]

Sample Disposal: Dispose [X] Return [ ]

LAB TEST CODES

SHADED AREA - FOR LAB USE ONLY

Lab 1 #: Lab 2 #:

Quote #: Kit Request #:

Project #:

No. of Samples: Page of

Login: LIMS Ver

Sampling Date	Sampling Time	Type COMP	Type GRAB	Matrix WATER	Matrix SOIL	Matrix AIR	CLIENT SAMPLE ID (9 CHARACTERS)	# OF CONTAINERS	ANALYSES REQUESTED: BIOASSAY REMAID V.	ANALYSES REQUESTED: BIOASSAY MYSIDOPSIS BAHA	REMARKS	LAB 1 ID	LAB 2 ID
3/24/95		X		X			JC05	1	X	X			

Sampled By & Title: SLCOSTA (Please sign and print name) — Date/Time: 3/24/95

Relinquished By (Please sign and print name) — Date/Time

Received By (Please sign and print name) — Date/Time

Relinquished By (Please sign and print name) — Date/Time

Received By (Please sign and print name) — Date/Time

Relinquished By (Please sign and print name) — Date/Time

Received By (Please sign and print name) — Date/Time

Shipped Via: UPS BUS Fed-Ex Hand Other DHL — Shipping #

Work Authorized By (Please sign and print name)

Remarks: PROCEDURES AS PER EPA RECOMMENDATIONS

QC Level: 1 2 3 Other:

COC Rec | ICE

Ana Req | TEMP

Cust Seal | PH

Instructions and Agreement Provisions on Reverse Side

DISTRIBUTION: Original - LAB, Yellow - LAB, Pink - Client

CH2MHILL

APPLIED SCIENCES LABORATORY

CHAIN OF CUSTODY RECORD AND AGREEMENT TO PERFORM SERVICES

CH2M Hill Project #: 0PE30702.EL.L5

Purchase Order #:

Project Name: JOINT CANNERY OUTFALL

Company Name/CH2M HILL Office:

Project Manager & Phone #: Mr. [ ] Ms. [ ] Dr. [X] STEVE COSTA 510-251-2426

Report Copy to: SAME

Requested Completion Date:

Sampling Requirements: SDWA [ ] NPDES [X] RCRA [ ] OTHER [ ]

Sample Disposal: Dispose [X] Return [ ]

Sampling Date	Sampling Time	Type COMP	Type GRAB	Matrix WATER	Matrix SOIL	Matrix AIR	CLIENT SAMPLE ID (9 CHARACTERS)	# OF CONTAINERS	ANALYSES REQUESTED: BIOASSAY V. PENAID	ANALYSES REQUESTED: BIOASSAY MYSIDOPSIS BAHIA
3/24/95		X		X			JC05	1	X	X

Sampled By & Title: SL COSTA — Date/Time: 3/24/95

Received By: MW FISLER — Date/Time: 3/24/95 1530

Received By — Date/Time

Received By — Date/Time

Work Authorized By

Relinquished By — Date/Time

Relinquished By — Date/Time

Relinquished By — Date/Time

Shipped Via: UPS BUS Fed-Ex Hand Other DHL — Shipping #

Remarks: PROCEDURES AS PER EPA RECOMMENDATIONS

Instructions and Agreement Provisions on Reverse Side

DISTRIBUTION: Original - LAB, Yellow - LAB, Pink - Client

REV 2/94 FORM 340

ATTACHMENT IV

LABORATORY REPORT
Advanced Biological Testing
96-hour Acute Bioassay

JOINT CANNERY OUTFALL EFFLUENT SAMPLES
March 23-24, 1995

RESULTS OF BIOASSAYS CONDUCTED ON AN EFFLUENT SAMPLE FROM THE JOINT CANNERY OUTFALL IN AMERICAN SAMOA USING *Penaeus vannami* AND *Mysidopsis bahia*

Prepared for:

CH2M Hill California, Inc.
1111 Broadway
Oakland, CA 94607
Project # PDX 30702

Prepared by:

Advanced Biological Testing Inc.
98 Main St., # 419
Tiburon, Ca. 94920

April 24, 1995

Ref: 9309-4

1.0 INTRODUCTION

At the request of CH2M Hill (Project # PDX 30702), Advanced Biological Testing conducted a four day effluent bioassay test on *Mysidopsis bahia* and *Penaeus vannami* using effluents collected from the joint cannery outfall at the Starkist and Van Camp tuna canneries in American Samoa. The studies were run using methods generally specified in EPA 1991. This is the fourth in a series of tests on this material. *Penaeus* is the preferred species, however in previous studies when *Penaeus* was unavailable, *Mysidopsis* was substituted. Since both species were available and have been tested previously separately, it was appropriate to continue with both species in this test.

The study was conducted at the Advanced Biological Testing Laboratory in Tiburon, California, and was managed by Mr. Mark Fisler.

2.0 METHODS

2.1 EFFLUENT SAMPLING

The effluents were sampled on March 23, 1995 by cannery personnel under the supervision of CH2M Hill. The sample was received by the laboratory on March 27, 1994. One five gallon carboy was provided, maintained in an ice-filled cooler from the date of sampling until laboratory receipt. The sample was at 5°C upon receipt.

2.2 SAMPLE PREPARATION

The effluent sample was immediately tested for water quality; the pH was 5.9, dissolved oxygen was 1.5 ppm, salinity was 14 ppt and the total ammonia was 7.27 mg/L. The effluent required salinity adjustment to 30 ppt. The effluent salinity was increased to 30 ppt with 100 ppt natural seawater brine. The brine was made from frozen Bodega Bay seawater. Due to the dilution of the effluent with the brine solution, the initial maximum concentration of effluent was 81%. The highest initial test concentration was then made by diluting the 81% effluent with Bodega Bay seawater to an actual effluent concentration of 50%.

The effluents were tested at an actual effluent concentration series of 50%, 25%, 12.5%, 6.25%, and 3.1% for both *Penaeus* and *Mysidopsis* as a vol:vol dilutions in seawater. A brine control was run with both test sets to assess the potential toxicity from the added brine. The diluent and the control water was filtered seawater from Bodega Bay. The dilutions were brought to the test temperature (20 - 25° ± 2°C) and aerated continuously. These effluents have an increasing biological oxygen demand, with a significant peak at 10-14 hours after test initiation. Previous testing of this effluent without initial aeration demonstrated significant toxicity at 24 hours (or before); therefore aeration was carried out from the beginning of the test. According to EPA methods the effluents were renewed with effluents held under refrigeration from test initiation on Day 2.

A reference toxicant was run using concentrations provided by the EPA. The toxicant was Sodium dodecyl sulfonate (SDS) made up as a 2 grams per liter stock solution in distilled water. The tested concentrations were set at 100, 50, 25, 12.5 and 6.25 mg/L in 31 ppt seawater.

2.3 TESTING PROCEDURES

The bioassay was carried out on three day old larvae of *Mysidopsis bahia* supplied by Aquatox in Arkansas and post-larval *Penaeus* provided by Brezina and Associates from Harlingen Shrimp Farm in Los Fresnos, Texas. The animals were air-shipped and were received at ABT on March 29, 1995. The test conditions are summarized in Tables 1 and 7. Five replicates of each concentration were tested with ten animals per replicate. Water quality was monitored daily as initial quality on Day 0 and final water quality on Days 1 through 4. Parameters measured included dissolved oxygen, pH, salinity, total ammonia, and temperature.

2.4 STATISTICAL ANALYSIS

At the conclusion of the test, the survival data were evaluated statistically using ToxCalc™ to determine ECp, NOEC, and TU values where appropriate. ToxCalc™ is a comprehensive statistical application that follows standard guidelines for acute and chronic toxicity data analysis. Statistical effects can be measured by the ECp, the estimated concentration that causes any effect, either lethal (LC) or sublethal (IC), on p% of the test population. The LCp is the point estimate of the concentration at which a lethal effect is observed in p% of the test organisms. ECp values include 95% confidence limits if available.

The NOEC (No Observable Effect Concentration) is the highest tested concentration at which mortality and other sublethal measured effects are not significantly different from the same parameters in the control. TU (Toxicity Units) are calculated as 100%/NOEC.

3.0 RESULTS

3.1 INTRODUCTION

Tables 1 and 7 summarize the test parameters and conditions. The results of the effluent and reference toxicant bioassays and the water quality monitoring for both sets of tests are presented.

3.2 TESTING WITH PENAEUS VANNAMI

In the *Penaeus* test, water quality measurements were within the acceptable limits provided in EPA 1991 (Tables 2 and 3). Temperature was maintained at 20 ± 1°C; pH remained relatively stable, and the salinity increased slightly as would be expected in a static test (Table 2). Aeration was maintained in all chambers for the duration of the test. Ammonia was 1.73 ppm in the 50% effluent. The test solutions were renewed with reserved effluent at 48 hrs.

No significant difference was found between the brine control and laboratory control. All statistical tests were run against the control. The LC50 for the effluent was 14.8% (95% confidence limits = 13.4% to 16.3%). There was significant mortality at the 12.5%, 25% and 50% concentrations compared to the control (Table 4). The NOEC was 6.25%, and the LOEC was 12.5%. The TU was 16.

The reference toxicant test had an LC50 of 19.47 mg/L, an NOEC of 12.5 mg/L, and an LOEC of 25 mg/L (Tables 5 and 6). The laboratory mean was 20.38 mg/L and the data is within one standard deviation of the laboratory mean, indicating normal sensitivity.

3.2 TESTING WITH MYSIDOPSIS BAHIA

In the *Mysidopsis* test, water quality measurements were within the acceptable limits provided in EPA 1991 (Tables 8 and 9). Temperature was maintained at 25 ± 1°C; pH remained relatively stable, and the salinity increased slightly as would be expected in a static test (Tables 1 and 2). Aeration was maintained in all chambers for the duration of the test. Ammonia was 1.96 ppm in the 50% effluent. The test solutions were renewed with reserved effluent at 48 hrs.

No significant difference was found between the brine control and laboratory control. All statistical tests were run against the control. The LC50 for the effluent was 10.8% (95%

confidence limits = 9.5% to 12.3%) (Table 10). There was significant mortality at the 12.5%, 25% and 50% concentrations compared to the control. The NOEC was 6.25%, and the LOEC was 12.5%. The TU was 16.

The reference toxicant test had an LC50 of 13.8 mg/L, an NOEC of 12.5 mg/L, and an LOEC of 25 mg/L (Tables 11 and 12). The laboratory mean was 12.5 mg/L for *Mysidopsis bahia* and the data is within one standard deviation of the laboratory mean, indicating normal sensitivity.

TABLE 1

Bioassay Procedure And Organism Data
For the Survival Bioassay
Using *Penaeus vannami* U.S. EPA 1991)

Parameter	Data
Sample Identification	
Sample ID(s)	950327-1
Date Sampled	3/23/95
Date Received at ABT	3/27/95
Volume Received	Five gallons
Sample Storage Conditions	4°C in the dark
Test Species	*Penaeus vannami*
Supplier	Harlingen Shrimp Farm, Los Fresnos, Texas
Collection location	In house colony
Date Acquired	3/29/95
Acclimation Time	Used immediately
Acclimation Water	Shipping water
Acclimation Temperature	20±2°C
Age group	Post larvae (approximately 8-10 mm)
Test Procedures	
Type; Duration	Acute, static/renewal at 48 hours
Test Dates	3/29/95 to 4/2/95
Control Water	Bodega Bay seawater
Test Temperature	20 ± 2°C
Test Photoperiod	16L : 8 D
Salinity	30± 2 ppt
Test Chamber	1000 mL jars
Animals/Replicate	10
Exposure Volume	500 mL
Replicates/Treatment	5
Feeding	Brine shrimp (24 hr old nauplii)
Deviations from procedures	None

TABLE 2

Penaeus vannami
INITIAL WATER QUALITY MEASUREMENTS
FOR EFFLUENT TEST
Initial Readings

Concentration	Day 0					Day 2				
(%)	pH	DO	NH3	°C	Sal	pH	DO	NH3	°C	Sal
Control	8.14	8.0	<0.1	20.9	30	8.03	9.4	0.02	NT	29
Brine	8.09	8.1	<0.1	19.7	30	8.07	9.4	0.02	19.2	30
3.1	8.02	8.0	0.21	19.9	30	7.82	7.8	0.17	19.6	31
6.25	7.82	7.8	0.40	19.8	30	7.66	6.4	0.34	19.2	30
12.5	7.47	7.4	0.75	19.4	30	7.38	4.8	0.59	19.2	30
25	7.00	6.7	1.57	18.4	30	—	—	—	—	—
50	6.60	5.9	3.10	18.4	30	—	—	—	—	—
Min	6.60	5.9	<0.1	18.4	30	7.38	4.8	<0.1	19.2	29
Max	8.14	8.1	3.1	20.9	30	8.07	9.4	0.6	19.6	31

Notes: — = All animals dead.
NT = Not taken.

TABLE 3

Penaeus vannami
WATER QUALITY MEASUREMENTS FOR EFFLUENT TEST

Concentration		Day 1					Day 2					Day 3					Day 4				
(%)	Rep	pH	DO	NH3	°C	Sal	pH	DO	NH3	°C	Sal	pH	DO	NH3	°C	Sal	pH	DO	NH3	°C	Sal
Control	1	8.13	8.4	0.03	19.9	30	8.10	8.2	0.04	21.0	30	7.94	8.0		19.9	30	7.99	8.5		19.0	30
	2	8.16	8.3		19.9	30	8.12	8.1		20.9	30	7.94	8.0		19.9	30	8.01	8.5		19.3	30
	3	8.16	8.4		20.4	30	8.11	8.1		20.9	31	7.91	8.2	0.02	19.9	30	7.99	8.5		19.3	30
	4	8.13	8.4		20.7	30	8.08	8.0		20.7	30	7.92	8.2		19.9	30	8.00	8.5	0.04	19.3	30
	5	8.17	8.2		20.6	30	8.12	8.0		21.0	30	8.00	8.1		19.9	30	8.10	8.7		19.3	30
Brine	1	8.19	8.1	0.02	19.9	30	8.26	7.9	0.03	21.0	30	8.15	8.0		19.9	31	8.27	8.6		19.3	31
Control	2	8.23	8.2		20.1	30	8.26	7.9		21.0	30	8.15	8.1		19.9	30	8.20	8.5		19.3	31
	3	8.23	8.2		20.5	30	8.28	7.8		20.9	30	8.16	8.1	0.02	19.9	30	8.22	8.6		19.3	31
	4	8.26	8.4		20.6	30	8.28	7.8		20.9	30	8.18	8.2		19.9	30	8.23	8.7	0.04	19.3	31
	5	8.25	8.2		19.9	30	8.26	7.9		20.9	30	8.15	8.0		19.9	30	8.21	8.7		19.3	31
3.1	1	8.11	7.9	0.11	19.8	30	8.16	7.8	0.18	21.0	30	7.96	8.1		19.9	31	8.08	8.6		19.4	31
	2	8.07	7.9		19.9	30	8.13	7.9		20.9	30	7.99	8.0		19.9	31	8.09	8.6		19.3	31
	3	8.07	8.0		20.1	30	8.13	7.9		21.0	30	8.06	7.9	0.15	19.9	31	8.15	8.7		19.3	31
	4	8.12	8.1		19.9	30	8.16	8.0		21.0	30	8.12	7.9		19.9	31	8.18	8.7	0.15	19.3	31
	5	8.13	7.9		19.6	30	8.15	8.0		20.9	30	8.06	7.9		19.9	31	8.12	8.5		19.3	31
6.25	1	8.09	7.9	0.23	19.0	30	8.16	7.9	0.34	20.9	30	8.09	7.9		19.9	31	8.18	8.6		19.5	31
	2	8.05	7.9		19.0	30	8.10	7.9		20.9	31	7.90	7.8		20.0	31	8.06	8.2		19.4	31
	3	8.03	8.0		19.0	30	8.05	7.9		21.0	30	7.91	7.9	0.33	19.9	31	8.06	8.4		19.3	31
	4	8.03	7.8		19.1	30	8.08	7.8		20.9	30	7.99	8.0		19.9	31	8.11	8.6	0.32	19.3	31
	5	8.09	7.8		19.0	30	8.00	8.0		21.0	30	7.86	8.0		19.9	30	7.95	8.0		19.3	31
12.5	1	7.84	7.9	0.43	19.0	30	7.95	7.9	0.59	21.0	30	7.74	8.1		20.1	30	7.96	8.1		19.5	31
	2	7.83	7.9		19.1	30	7.94	7.6		21.0	30	7.79	7.9		20.1	30	7.99	8.1		19.4	31
	3	7.83	7.7		19.0	30	8.12	7.7		21.0	30	8.03	7.7	0.65	19.9	31	8.14	8.6		19.4	31
	4	7.82	7.8		19.1	30	8.06	7.8		20.9	30	7.90	7.8		19.9	30	8.06	8.2	0.72	19.4	31
	5	7.78	7.9		19.1	30	8.12	7.8		21.0	30	—	—		—	—	—	—		—	—
25	1	7.66	6.0	0.90	19.0	30	8.02	7.8	0.89	21.0	30	—	—		—	—	—	—		—	—
	2	7.57	3.0		19.0	30	7.86	7.9		21.0	30	—	—		—	—	—	—		—	—
	3	7.60	5.6		19.1	30	7.87	7.9		20.9	30	—	—	—	—	—	—	—		—	—
	4	7.59	2.4		19.0	30	7.82	8.0		20.9	30	—	—		—	—	—	—		—	—
	5	7.56	1.8		19.0	30	7.91	8.1		20.9	30	—	—		—	—	—	—	—	—	—
50	1	7.62	5.6	1.73	19.0	30	8.13	8.2	2.34	21.0	30	—	—		—	—	—	—		—	—
	2	7.63	6.0		19.1	30	8.21	8.1		21.0	30	—	—		—	—	—	—		—	—
	3	7.64	5.7		19.1	30	7.92	7.3		20.9	30	—	—		—	—	—	—		—	—
	4	7.64	4.7		19.0	30	8.08	8.0		21.0	30	—	—	—	—	—	—	—		—	—
	5	7.60	1.7		19.0	30	8.07	7.9		21.0	30	—	—		—	—	—	—	—	—	—
Min		7.56	1.7	0.02	19.0	30	7.82	7.3	0.03	20.7	30	7.74	7.7	0.02	19.9	30	7.95	8.0	0.04	19.0	30
Max		8.26	8.4	1.73	20.7	30	8.28	8.2	2.34	21.0	31	8.18	8.2	0.65	20.1	31	8.27	8.7	0.72	19.5	31

Note: — = All animals dead.

TABLE 4

Penaeus vannami
SURVIVAL DATA FOR EFFLUENT TEST

Concentration (%)	Rep	Initial Added	Day 1	Day 2	Day 3	Day 4	% Survival	Average % Survival
Control	1	10	10	10	10	9	90	
	2	10	10	10	10	10	100	
	3	10	10	10	10	10	100	
	4	10	9	9	9	9	90	
	5	10	10	10	10	9	90	94.0
Brine	1	10	9	9	9	9	90	
Control	2	10	10	10	10	10	100	
	3	10	9	8	8	8	80	
	4	10	10	10	10	10	100	
	5	10	10	10	10	10	100	94.0
3.1	1	10	9	8	8	8	80	
	2	10	10	10	10	10	100	
	3	10	8	8	8	8	80	
	4	10	8	9	9	9	90	
	5	10	10	10	10	10	100	90.0
6.25	1	10	10	10	10	10	100	
	2	10	10	10	10	10	100	
	3	10	9	9	9	9	90	
	4	10	10	9	9	9	90	
	5	10	9	9	9	8	80	92.0
12.5	1	10	3	9	9	9	90	
	2	10	4	9	9	8	80	
	3	10	5	10	10	10	100	
	4	10	4	9	9	8	80	
	5	10	5	0	—	—	0	70.0
25	1	10	*	0	—	—	0	
	2	10	*	0	—	—	0	
	3	10	*	0	—	—	0	
	4	10	*	0	—	—	0	
	5	10	*	0	—	—	0	0.0
50	1	10	*	0	—	—	0	
	2	10	*	0	—	—	0	
	3	10	*	0	—	—	0	
	4	10	*	0	—	—	0	
	5	10	*	0	—	—	0	0.0

Notes: — = All animals dead.
* = Water too cloudy to count animals.

TABLE 5

Penaeus vannami
WATER QUALITY MEASUREMENTS
FOR REFERENCE TOXICANT (S.D.S) TEST

Concentration		Day 0				Day 1				Day 2				Day 3				Day 4			
(mg/L)	Rep	pH	DO	°C	Sal	pH	DO	°C	Sal	pH	DO	°C	Sal	pH	DO	°C	Sal	pH	DO	°C	Sal
Control	1	8.04	8.1	20.3	30	8.09	7.4	19.1	30	7.96	8.0	21.0	30	7.84	5.8	19.8	31	7.90	6.1	19.3	31
	2					8.10	7.4	19.0	30	7.94	7.9	21.0	30	7.81	5.4	19.8	31	7.85	5.8	19.3	31
	3					8.09	7.5	19.0	30	7.95	7.8	20.9	30	7.81	5.6	19.8	31	7.86	5.9	19.3	31
6.25	1	8.05	7.9	20.3	30	8.00	5.6	19.1	30	7.90	7.8	21.0	30	7.81	5.6	19.8	31	7.87	6.0	19.3	31
	2					7.96	5.7	19.0	30	7.89	7.7	21.0	30	7.81	5.5	19.8	31	7.87	6.0	19.3	31
	3					7.96	5.7	19.0	30	7.89	7.6	21.0	30	7.81	5.4	19.8	31	7.87	6.0	19.3	31
12.5	1	8.07	8.0	20.3	30	7.91	4.4	19.0	30	7.86	7.7	21.0	30	7.76	5.0	19.8	31	7.86	6.0	19.3	31
	2					7.87	4.0	19.0	30	7.83	7.2	21.0	30	7.74	4.8	19.8	31	7.82	5.7	19.3	31
	3					7.86	4.0	19.0	30	7.84	7.2	21.0	30	7.75	4.7	19.8	31	7.84	5.8	19.3	31
25	1	8.07	8.1	20.4	30	7.88	4.3	19.0	30	7.72	7.4	21.0	30	7.76	5.8	19.7	31	7.81	5.7	19.2	31
	2					7.88	4.2	19.0	31	7.65	7.5	20.9	31	7.76	5.5	19.7	31	7.76	5.3	19.2	31
	3					7.87	3.4	19.0	31	7.65	7.3	20.9	31	7.74	5.6	19.7	31	7.76	5.5	19.2	31
50	1	8.08	8.1	20.4	30	7.88	4.2	19.0	30	7.55	7.1	21.0	30	7.63	2.9	19.7	31	—	—	—	—
	2					7.90	4.2	19.0	30	7.54	7.0	21.0	30	7.54	2.8	19.7	31	—	—	—	—
	3					7.87	2.9	19.1	30	—	—	—	—	—	—	—	—	—	—	—	—
100	1	8.08	8.0	20.5	30	7.94	5.2	19.0	31	—	—	—	—	—	—	—	—	—	—	—	—
	2					7.99	5.6	19.1	31	—	—	—	—	—	—	—	—	—	—	—	—
	3					7.98	5.1	19.0	30	—	—	—	—	—	—	—	—	—	—	—	—
Min		8.04	7.9	20.3	30	7.86	2.9	19.0	30	7.54	7.0	20.9	30	7.54	2.8	19.7	31	7.76	5.3	19.2	31
Max		8.08	8.1	20.5	30	8.10	7.5	19.1	31	7.96	8.0	21.0	31	7.84	5.8	19.8	31	7.90	6.1	19.3	31

Note: — = All animals dead.

TABLE 6

Penaeus vannami
SURVIVAL DATA FOR REFERENCE TOXICANT (S.D.S.) TEST

Concentration (mg/L)	Rep	Initial Added	Day 1	Day 2	Day 3	Day 4	% Survival	Average % Survival
Control	1	10	10	10	9	8	80	
	2	10	10	10	10	10	100	
	3	10	10	10	10	10	100	93.3
6.25	1	10	10	10	10	10	100	
	2	10	10	10	10	10	100	
	3	10	10	10	10	10	100	100.0
12.5	1	10	9	7	7	7	70	
	2	10	10	10	10	10	100	
	3	10	8	8	8	8	80	83.3
25	1	10	4	2	2	2	20	
	2	10	5	5	5	4	40	
	3	10	4	3	3	2	20	26.7
50	1	10	1	0	—	—	0	
	2	10	1	0	—	—	0	
	3	10	0	—	—	—	0	0.0
100	1	10	0	—	—	—	0	
	2	10	0	—	—	—	0	
	3	10	0	—	—	—	0	0.0

Note: — = All animals dead.

TABLE 7

Bioassay Procedure And Organism Data
For the Survival Bioassay
Using *Mysidopsis bahia* (U.S. EPA 1991)

Parameter	Data
Sample Identification	
Sample ID(s)	950327-1
Date Sampled	3/23/95
Date Received at ABT	3/27/95
Volume Received	Five gallons
Sample Storage Conditions	4°C in the dark
Test Species	*Mysidopsis bahia*
Supplier	Aquatox, Hot Springs, Arkansas
Collection location	In house colony
Date Acquired	3/29/95
Acclimation Time	Used immediately
Acclimation Water	Shipping water
Acclimation Temperature	25±2°C
Age group	Three day old larvae
Test Procedures	
Type; Duration	Acute, static/renewal at 48 hours
Test Dates	3/29/95 to 4/2/95
Control Water	Bodega Bay seawater
Test Temperature	25± 2°C
Test Photoperiod	14 L : 10 D
Salinity	32± 2 ppt
Test Chamber	1000 mL jars
Animals/Replicate	10
Exposure Volume	500 mL
Replicates/Treatment	5
Feeding	Brine shrimp (<24 hr old nauplii)
Deviations from procedures	None

TABLE 8

Mysidopsis bahia
INITIAL WATER QUALITY MEASUREMENTS
FOR EFFLUENT TEST
Initial Readings

Concentration	Day 0					Day 2				
(%)	pH	DO	NH3	°C	Sal	pH	DO	NH3	°C	Sal
Control	8.16	7.2	<0.1	24.5	30	8.12	9.4	0.02	25.2	29
Brine	8.09	7.4	<0.1	24.4	30	7.96	9.2	0.02	24.5	30
3.1	8.03	7.2	0.21	24.4	30	7.72	7.5	0.17	24.9	31
6.25	7.85	6.8	0.40	24.4	30	7.54	6.5	0.34	24.9	30
12.5	7.63	6.3	0.75	24.5	30	7.33	4.6	0.59	24.5	30
25	7.34	5.4	1.57	24.5	30	—	—	—	—	—
50	7.03	4.4	3.10	24.6	30	—	—	—	—	—
Min	7.03	4.4	<0.1	24.4	30	7.33	4.6	0.02	24.5	29
Max	8.16	7.4	3.1	24.6	30	8.12	9.4	0.59	25.2	31

Note: — = All animals dead.

TABLE 9

Mysidopsis bahia
WATER QUALITY MEASUREMENTS FOR EFFLUENT TEST
Final Readings

Concentration		Day 1					Day 2					Day 3					Day 4				
(%)	Rep	pH	DO	NH3	°C	Sal	pH	DO	NH3	°C	Sal	pH	DO	NH3	°C	Sal	pH	DO	NH3	°C	Sal
Control	1	8.21	8.0	0.02	24.9	31	8.15	8.2	0.03	24.4	32	8.04	8.2		25.9	31	8.11	7.0		24.1	32
	2	8.21	7.8		24.9	30	8.16	8.3		24.9	32	8.05	8.4		26.0	31	8.12	7.1		24.1	32
	3	8.18	7.9		24.9	31	8.13	8.3		24.9	32	8.03	8.2	0.03	25.8	31	8.07	6.9		24.2	32
	4	8.23	8.0		24.9	31	8.18	8.4		25.0	32	8.11	8.2		25.9	31	8.19	7.2	0.02	24.1	32
	5	8.18	8.0		24.9	31	8.15	8.2		24.9	32	8.05	8.0		26.0	31	8.10	7.1		24.1	32
Brine	1	8.31	7.8	0.01	24.9	31	8.27	8.0	0.03	25.0	32	8.22	8.0		26.0	32	8.33	7.2		24.2	32
Control	2	8.29	7.8		24.9	31	8.30	8.0		24.9	32	8.25	7.9		25.9	32	8.32	7.2		24.2	32
	3	8.27	7.9		24.9	31	8.30	8.2		24.9	32	8.22	7.9	0.02	26.0	32	8.30	7.1		24.1	32
	4	8.28	8.0		24.9	31	8.29	8.2		24.9	32	8.21	8.0		25.9	32	8.30	7.1	0.02	24.1	32
	5	8.27	8.0		24.8	31	8.27	8.2		24.9	32	8.22	8.0		25.9	32	8.29	7.1		24.2	32
3.1	1	8.12	7.6	0.16	24.9	31	8.16	8.2	0.18	25.0	32	8.06	8.0		26.0	32	8.16	7.0		24.3	32
	2	8.07	7.8		24.9	31	8.10	8.3		25.0	32	7.98	7.9		26.0	32	8.10	7.0		24.2	32
	3	7.98	7.6		24.9	31	8.18	8.3		25.0	32	8.10	7.9	0.15	25.9	32	8.09	7.2		24.1	32
	4	7.99	7.7		24.9	31	8.08	8.3		25.0	32	8.05	8.0		25.9	32	8.22	7.0	0.24	24.1	32
	5	7.93	7.8		24.9	31	7.97	8.0		24.9	32	7.93	8.0		26.0	32	8.05	6.7		24.1	32
6.25	1	7.93	7.9	0.28	24.9	31	8.00	7.9	0.35	24.9	32	7.86	8.0		26.0	32	8.01	6.8		24.2	32
	2	8.01	7.9		25.0	31	8.06	8.0		25.1	32	7.99	8.0		26.0	32	8.13	7.1		24.1	32
	3	8.10	8.0		25.0	31	8.14	8.0		24.9	32	8.07	7.9	0.32	26.0	32	8.19	6.9		24.2	32
	4	8.02	8.0		24.9	31	8.08	7.9		24.9	33	7.99	7.8		25.9	32	8.10	6.8	0.45	24.2	32
	5	7.99	7.9		24.9	31	8.04	8.0		24.9	33	7.94	7.9		25.9	32	8.08	6.9		24.1	32
12.5	1	7.97	8.0	0.47	25.0	31	8.07	8.0	0.59	25.1	32	7.89	7.9		26.0	32	8.08	6.9		24.3	32
	2	7.92	8.1		24.9	31	8.03	7.9		25.0	32	7.86	7.9		26.0	32	8.04	6.6		24.3	32
	3	7.86	8.0		24.9	31	7.97	7.9		24.9	32	7.82	8.0	0.62	25.9	32	8.01	6.4		24.2	32
	4	7.59	6.9		24.8	31	8.06	8.0		24.9	33	7.99	8.0		26.0	32	8.13	6.9	0.76	24.3	32
	5	8.09	7.8		24.9	31	8.17	7.8		24.9	33	7.94	8.0		26.0	32	8.18	7.0		24.2	32
25	1	7.84	7.6	0.97	25.0	31	8.03	7.9	0.89	25.1	32	—	—	—	—	—	—	—	—	—	—
	2	7.91	7.8		25.0	31	8.02	7.8		25.1	32	—	—	—	—	—	—	—	—	—	—
	3	7.90	7.4		24.9	31	7.98	8.0		25.0	32	—	—	—	—	—	—	—	—	—	—
	4	7.63	6.4		24.9	31	7.98	8.0		25.0	32	—	—	—	—	—	—	—	—	—	—
	5	7.65	7.2		24.9	31	8.09	8.1		25.0	33	—	—	—	—	—	—	—	—	—	—
50	1	7.77	7.0	1.96	25.0	30	7.88	7.9	2.34	25.1	32	—	—	—	—	—	—	—	—	—	—
	2	7.67	7.2		25.0	30	7.86	7.9		25.1	32	—	—	—	—	—	—	—	—	—	—
	3	7.70	7.4		24.9	30	7.74	8.0		25.1	32	—	—	—	—	—	—	—	—	—	—
	4	7.71	7.4		24.9	31	7.72	8.0		25.0	32	—	—	—	—	—	—	—	—	—	—
	5	7.81	7.6		24.9	31	7.80	8.1		25.0	32	—	—	—	—	—	—	—	—	—	—
Min		7.59	6.4	0.01	24.8	30	7.72	7.8	0.03	24.4	32	7.82	7.8	0.02	25.8	31	8.01	6.4	0.02	24.1	32
Max		8.31	8.1	1.96	25.0	31	8.30	8.4	2.34	25.1	33	8.25	8.4	0.62	26.0	32	8.33	7.2	0.76	24.3	32

Note: — = All animals dead.

TABLE 10

Mysidopsis bahia
SURVIVAL DATA FOR EFFLUENT TEST

Concentration (%)	Rep	Initial Added	Day 1	Day 2	Day 3	Day 4	% Survival	Average % Survival
Control	1	10	10	10	10	10	100	
	2	10	10	9	9	9	90	
	3	10	10	10	10	10	100	
	4	10	10	10	10	10	100	
	5	10	10	9	9	9	90	96.0
Brine Control	1	10	10	10	10	10	100	
	2	10	10	10	10	10	100	
	3	10	10	10	10	10	100	
	4	10	10	9	9	9	90	
	5	10	10	10	10	10	100	98.0
3.1	1	10	10	9	9	8	80	
	2	10	10	9	9	7	70	
	3	10	9	9	9	9	90	
	4	10	10	9	9	7	70	
	5	10	10	10	10	10	100	82.0
6.25	1	10	10	10	10	10	100	
	2	10	10	10	10	10	100	
	3	10	10	9	9	9	90	
	4	10	9	9	9	8	80	
	5	10	10	10	10	8	80	90.0
12.5	1	10	10	10	10	10	100	
	2	10	6	6	6	2	20	
	3	10	2	2	1	1	10	
	4	10	1	3	1	1	10	
	5	10	8	8	5	5	50	38.0
25	1	10	*	0	—	—	0	
	2	10	*	0	—	—	0	
	3	10	*	0	—	—	0	
	4	10	*	0	—	—	0	
	5	10	*	0	—	—	0	0.0
50	1	10	*	0	—	—	0	
	2	10	*	0	—	—	0	
	3	10	*	0	—	—	0	
	4	10	*	0	—	—	0	
	5	10	*	0	—	—	0	0.0

Notes: * = Water too cloudy to count animals.
— = All animals dead.

TABLE 11

Mysidopsis bahia
WATER QUALITY MEASUREMENTS
FOR REFERENCE TOXICANT (S.D.S) TEST

Concentration		Day 0				Day 1				Day 2				Day 3				Day 4			
(mg/L)	Rep	pH	DO	°C	Sal	pH	DO	°C	Sal	pH	DO	°C	Sal	pH	DO	°C	Sal	pH	DO	°C	Sal
Control	1	8.07	7.4	24.0	30	8.15	7.6	24.7	31	8.11	8.0	24.8	32	7.97	5.6	26.0	33	8.04	6.5	24.1	33
	2					8.16	7.6	24.8	31	8.13	7.8	24.8	32	8.02	5.5	26.0	33	8.11	6.6	24.1	33
	3					8.16	7.8	24.8	31	8.14	7.9	24.8	32	8.02	5.5	26.0	33	8.09	6.5	24.1	33
1.6	1	8.07	7.4	24.1	30	8.14	7.7	24.9	31	8.14	7.6	24.9	32	8.04	5.5	25.8	33	8.13	6.3	24.1	33
	2					8.13	7.8	24.9	31	8.13	7.4	24.9	32	8.06	5.6	26.0	33	8.15	6.6	24.2	33
	3					8.13	7.7	24.9	31	8.11	7.4	24.9	32	8.03	5.6	25.9	33	8.12	6.4	24.1	33
3.1	1	8.07	7.0	24.2	30	8.10	7.4	24.9	31	8.08	7.0	25.0	32	8.00	5.4	26.0	33	8.11	6.5	24.1	33
	2					8.09	7.5	24.9	31	8.08	7.6	24.9	32	8.00	5.5	25.7	33	8.09	6.3	24.3	33
	3					8.08	7.3	24.9	31	8.08	7.2	24.9	32	7.96	5.1	25.9	33	8.06	6.3	24.1	33
6.25	1	8.08	6.9	24.2	30	8.03	6.1	24.9	31	8.05	6.9	25.0	32	7.97	5.4	26.0	33	8.06	6.3	24.1	33
	2					8.01	6.0	24.9	31	8.03	7.0	25.0	32	7.96	5.3	26.0	33	8.05	6.3	24.1	33
	3					8.01	6.0	24.9	31	8.04	7.0	24.9	32	7.98	5.4	26.0	33	8.09	6.5	24.1	33
12.5	1	8.08	7.0	24.2	30	8.00	5.6	24.9	31	8.00	7.2	24.9	32	8.00	6.0	25.9	33	8.07	6.3	24.2	33
	2					8.00	5.7	24.9	31	7.97	6.3	24.9	32	8.00	6.0	25.7	33	8.08	6.5	24.1	33
	3					7.99	5.5	24.9	31	7.97	6.4	25.0	32	7.99	6.0	25.6	33	8.05	6.5	24.3	33
25	1	8.08	6.9	24.0	31	8.01	5.9	24.6	31	7.86	7.0	24.9	33	—	—	—	—	—	—	—	—
	2					8.02	5.9	24.7	31	7.84	7.2	24.8	33	—	—	—	—	—	—	—	—
	3					8.02	5.8	24.8	31	7.83	7.1	24.9	33	—	—	—	—	—	—	—	—
Min		8.07	6.9	24.0	30	7.99	5.5	24.6	31	7.83	6.3	24.8	32	7.96	5.1	25.6	33	8.04	6.3	24.1	33
Max		8.08	7.4	24.2	31	8.16	7.8	24.9	31	8.14	8.0	25.0	33	8.06	6.0	26.0	33	8.15	6.6	24.3	33

Note: — = All animals dead.

TABLE 12

Mysidopsis bahia
SURVIVAL DATA FOR REFERENCE TOXICANT (S.D.S.) TEST

Concentration (mg/L)	Rep	Initial Added	Day 1	Day 2	Day 3	Day 4	% Survival	Average % Survival
Control	1	10	10	10	10	10	100	
	2	10	10	10	10	10	100	
	3	10	10	10	10	9	90	96.7
1.6	1	10	10	9	8	7	70	
	2	10	10	9	9	9	90	
	3	10	10	9	9	9	90	83.3
3.1	1	10	10	10	10	10	100	
	2	10	10	9	9	9	90	
	3	10	10	10	10	10	100	96.7
6.25	1	10	10	10	10	9	90	
	2	10	10	10	10	10	100	
	3	10	9	9	9	8	80	90.0
12.5	1	10	9	7	7	7	70	
	2	10	10	9	9	9	90	
	3	10	9	9	9	9	90	83.3
25	1	10	1	0	—	—	0	
	2	10	1	0	—	—	0	
	3	10	4	0	—	—	0	0.0

Note: — = All animals dead.

4.0
REFERENCES

U.S. EPA. 1991. Methods for measuring acute toxicity of effluents to freshwater and marine organisms, 4th ed. EPA 600/4-90/027, September, 1991.

PREPARED FOR: StarKist Samoa, Inc.
VCS Samoa Packing Company

PREPARED BY: Steve Costa/CH2M HILL/SFO
David Wilson/CH2M HILL/SEA
Tim Hamaker/CH2M HILL/RDD

DATE: 10 May 1993

SUBJECT: **Bioassay Testing of Effluent**
February 1993 Sampling

PROJECT: PDX30702.EL.R1

Purpose

This memorandum presents the results of the effluent bioassay testing of the Joint Cannery Outfall effluent sample that was collected in February 1993. This is the first of the required semi-annual tests. Previous Technical Memoranda described the results of concurrent effluent chemistry testing.

Study Objectives

Section D.1 of the StarKist Samoa and VCS Samoa Packing NPDES permits requires that semi-annual definitive acute bioassays (96-hour, static bioassays) be conducted on the cannery effluent. The purpose of these bioassays is to determine whether, and at what effluent concentration, acute toxicity may be detected for the effluent.

These bioassays are to be conducted using the white shrimp, *Penaeus vannamei* (postlarvae). The acute biomonitoring effluent sampling must be concurrent with effluent sampling for priority pollutant chemical analysis. Effluent samples are to be collected as 24-hour composite samples.

The first semi-annual effluent acute bioassay was conducted using a composite effluent from both the StarKist Samoa and VCS Samoa Packing facilities, as approved by EPA. This combined effluent bioassay is representative of the wastewater discharged from the Joint Cannery Outfall.

Effluent Sampling Methods

Between 0900 on February 16th and 0900 on February 17th, 1993, a 24-hour, flow-weighted composite sample of final effluent was collected from both the StarKist Samoa and VCS Samoa Packing treatment plant discharges. Samples were collected from the established effluent sampling sites following the routine composite sample collection schedule for the plants.

A total of eight grab samples were collected into pre-cleaned 5-gallon plastic cubitainers at each plant. Samples were collected at three-hour intervals over a 24 hour period. The samples were stored on ice until the completion of the 24-hour sampling period. After all samples were collected a flow-proportioned composite sample was prepared. The grab sample collection times and the relative effluent volumes calculated from plant flow records are summarized in Table 1. The relative effluent volumes were used to prepare the final composite sample, which was used to fill the sample containers shipped to the laboratory for testing.

Table 1
StarKist Samoa and VCS Samoa Packing 24-hour Composite Sample for Bioassay Testing
February 16-17, 1993

Grab Sample Number	VCS Samoa Packing		StarKist Samoa		VCS Samoa Packing Percent of Total Flow	StarKist Samoa Percent of Total Flow
	Sampling Time	Effluent Flow Rate (gpm)	Sampling Time	Effluent Flow Rate (gpm)		
1	1200	540	1100	950	36	64
2	1500	540	1400	800	40	60
3	1800	540	1700	800	40	60
4	2200	550	2000	800	41	59
5	2400	560	2300	800	41	59
6	0300	680	0200	850	44	56
7	0600	640	0500	850	43	57
8	0900	620	0800	825	43	57
Mean		584		834	41	59

Sample cubitainers were packed on ice in ice chests for shipment to the laboratory. Sample chain of custody forms were completed and then sealed into zip-lock bags and taped inside the lid of the ice chest. Samples were shipped as checked luggage on flights from Pago Pago to Honolulu and then to San Francisco. Samples that were composited on February 17th, were delivered to the testing laboratory at 0930 on February 19th. Laboratory bioassay test reports and chain-of-custody forms are attached to this memorandum. The chain of custody forms are included in Attachment I and the laboratory test report is included as Attachment II.

Results

The bioassay tests were conducted by MEC Analytical Systems, Inc., Tiburon, California. The results were provided by the laboratory in the *Summary Report for an Acute Bioassay Conducted under NPDES* dated March 18, 1993 included as Attachment II. This report summarizes the 96-hour acute bioassay test conducted with reference to the EPA document *EPA/600/4-90/027* as the source of methods for conducting the test.

The results of the bioassay tests (LC50 = 4.8-percent effluent; NOEC = 3.13-percent effluent) indicate that: [1] whole effluent at high concentrations may be toxic under laboratory conditions or, [2] the standard bioassay laboratory test procedures may not be appropriate for this type of effluent. Based on the test data the latter appears to be the more likely. Neither of these possibilities should be of concern. The consequences of both possible interpretations are as follows:

[1] The maximum whole effluent toxicity potentially indicated by the laboratory tests (but not confirmed) would require a dilution of about 32:1 (3-percent effluent concentration) to achieve non-toxic levels after one to three days of exposure. Under actual field conditions in Pago Pago Harbor the initial dilutions, under worst case conditions, are predicted to be about 350:1 (0.29-percent effluent concentration) which is achieved in less than two minutes. This is over ten times the 32:1 level indicated above. Therefore, under actual field conditions, organisms will not be exposed to effluent at potentially toxic levels present under laboratory conditions..

The indicated 32:1 level represents a toxicity mixing zone considerably smaller than that already provided in the NPDES permits for ammonia. For example, using the results of the modeling previously done for the mixing zone application, assuming worst case conditions, a dilution of 32:1 is predicted within 12 seconds of discharge and within 6½ meters of the diffuser ports. Given the depth of discharge (about 180 feet) and the

high discharge jet velocity, it is unlikely that any organism could be exposed to effluent at less than 32:1 for more than a few seconds.

[2] The effluent probably has a high immediate dissolved oxygen demand (IDOD) which may be responsible for the observed bioassay results. The low dissolved oxygen (DO) measured after 24 hours during the laboratory tests would account for observed mortality (see test results in Attachment II). Supplementary tests, as described in the test results, did not include measurements to investigate short term IDOD effects. To determine the influence of IDOD, it is recommended below that the laboratory procedure be modified to remove the IDOD from the effluent sample prior to bioassay testing.

Under actual discharge conditions initial mixing is much more rapid (seconds) than IDOD effects (minutes to hours) and no measurable DO sag due to IDOD would be observed. Therefore, mortality of test organisms attributable to IDOD effects is an artificial laboratory testing effect that would not be observed under actual discharge conditions.

Discussion

The survival data from this test are relatively self explanatory. In laboratory tests the effluent appears to produce mortality in the test organism at concentrations of approximately 3- to 6-percent after 24 hours of exposure. The 96-hour LC50 value was determined to be 4.8-percent effluent (±0.5-percent effluent at 95-percent confidence limits). The NOEC value was determined to be 3.13-percent effluent. The cause of the mortality is uncertain. High un-ionized ammonia, a pronounced dissolved oxygen sag over the first day of the test, a high immediate dissolved oxygen demand (IDOD), and low pH all could potentially have contributed to observed laboratory test results. The following analyses were conducted to examine each of these factors:

- **Ammonia.** Un-ionized ammonia was calculated to be 0.215 mg/l in 100-percent effluent and 0.021 mg/l in 6.25-percent effluent. No available data was found for ammonia toxicity to *Penaeus vannamei.* For other shrimp species LC50 values for un-ionized ammonia vary widely from 0.23 to 3.41 mg/l. Such data suggest that constituents or conditions other than or in addition to ammonia are involved in producing the observed test results.

- **BOD.** The high BOD levels of the effluent resulted in a significant and potentially lethal DO sag over the first 24 hours of the test (aeration was

used throughout the remainder of the test and no additional mortality was observed). The laboratory ran additional tests to determine if low dissolved oxygen was responsible for the observed test results. Extra sample was used to prepare 25- and 50-percent concentrations that were aerated. After 24 hours 100-percent mortality had occurred, although DO levels at the end of the test were high enough to prevent mortality. This could be interpreted to indicate that mortality did not solely result from low DO levels over the first 24 hours. However, the tests were not continuously monitored for DO. Therefore a rapid, immediate, and lethal DO sag with subsequent recovery to nonlethal DO levels (as described below) would not have been detected.

- **IDOD.** The supplementary tests, described above, may not have identified effects of high IDOD in the effluent. The effluent may exhibit a rapid DO demand within a time scale of minutes to hours. This could result in a transient lethal DO level that would not be detected under standard laboratory monitoring procedures. After an initial DO sag, subsequent continuous aeration would elevate DO to acceptable and non-lethal concentrations. Mortality could be induced by the IDOD induced transient DO sag. IDOD measurements and modified bioassay procedures are recommended for the next test period to resolve this issue.

- **pH.** Many species of shrimp have relatively narrow tolerances to changes in pH. Natural seawater has a pH range of approximately 7.9-8.3. Initial pH values during the test were somewhat lower than the natural values, but probably still within the tolerance range for *Penaeus vannamei.* For the initial test solution, pH varied with increased effluent concentration, decreasing from pH 7.63 in the 1.56-percent effluent (and the control group), to pH 7.06 in the 50-percent effluent. An initial pH of 7.33 was measured in 100-percent effluent. Mortalities of 10- and 100-percent were observed for concentrations of 3.13- and 6.25-percent effluent, respectively. Corresponding initial pH values were 7.67 and 7.5, respectively. After 24 hours corresponding pH values were 7.55 and 7.26, respectively. This is a narrow range of pH values, within the expected tolerance range of the organism, and it is unlikely that pH is solely responsible for the bioassay test results observed.

The mortality dose response curve for this effluent was very steep in this bioassay test. This result indicates that a threshold (of effluent concentration) was reached beyond which mortality occurred. The cause of laboratory test results is not known, but high IDOD is suspected as the primary cause. It is important to recognize that the potential

exposure time of organisms to actual discharged effluent in the harbor is extremely limited. A 3.13-percent effluent concentration (the NOEC) is equivalent to a dilution of 32:1. The modeling done for the mixing zone application indicates that, for worst case conditions, a 32:1 dilution is reached within 12 seconds of discharge from the diffuser within a distance of about 6½ meters from the discharge port. This rapid mixing would entirely eliminate the effects of high IDOD or any potentially toxic constituent.

Conclusions and Recommendations

The laboratory test results for the Joint Cannery Outfall effluent are not of concern. Ammonia effluent limitations are incorporated into the NPDES permit. For example, the ammonia limits were based on a toxicity mixing zone represented by an initial dilution of 80:1. Therefore, existing effluent limitations and permit conditions exceed those required to account for the laboratory bioassay test results for the effluent.

The laboratory conducting the tests was selected based on an evaluation by CH2M HILL of a list of five candidate laboratories. The tests were conducted in a thorough manner and the results appear valid and scientifically sound. Laboratory staff have suggested that aeration be started immediately on subsequent tests. Since the test species is not a standard bioassay species reference toxicant quality control charts have not been developed. For the limited testing to be conducted (once every 6 months) the development of reference toxicant information is not recommended.

The observed bioassay results may have been induced in the laboratory by high IDOD levels. CH2M HILL recommends that IDOD be measured in the effluent prior to the next bioassay test. If the IDOD measurements indicate a potential cause of mortality, the bioassay test procedure should be modified to eliminate IDOD prior to testing. The proposed modified procedure will be made available for review by USEPA and ASEPA. Parallel tests would be run following standard procedures.

Difficulty was found in obtaining the organisms for the test. The organism is a common aquiculture species but not a standard bioassay species. Therefore, the postlarval life stage is not always available and is difficult to obtain in small quantities. This results in a relatively expensive test organism that may not be available at the time scheduled for future testing. CH2M HILL strongly recommends that an alternate organism be selected and approved by the U.S. Environmental Protection Agency and the American Samoa Environmental Protection Agency prior to the next scheduled test in August 1993.

ATTACHMENT I

CHAIN OF CUSTODY FORMS

JOINT CANNERY OUTFALL EFFLUENT SAMPLES
February 16 and 17, 1993

STARKIST SAMOA, INC. and VCS SAMOA PACKING COMPANY

CH2M HILL

QUALITY ANALYTICAL LABORATORIES

CHAIN OF CUSTODY RECORD AND AGREEMENT TO PERFORM SERVICES

CH2M HILL Project #: ☐☐☐☐☐☐☐☐.☐☐.☐☐

Purchase Order #:

Project Name: Starkist / Samoa NPDES

Company Name/CH2M HILL Office: CH2M-Hill - Seattle / SFO

Project Manager & Phone #: Mr. [ ] Ms. [ ] Dr. [ ] David Wilson

Report Copy to: Steve Costa

Requested Completion Date:

Sampling Requirements: SDWA ☐ NPDES ☒ RCRA ☐ OTHER ____

Sample Disposal: Dispose ☐ Return ☐

LAB TEST CODES

SHADED AREA -- FOR LAB USE ONLY

Lab 1 #: Lab 2 #:

Quote #: Kit Request #:

ANALYSES REQUESTED

Project #:

No. of Samples: Page: of:

COC Rev: Login: LIMS Ver: Ack Gen:

REMARKS: LAB 1 ID: LAB 2 ID:

Sampling Date	Sampling Time	Type COMP	Type GRAB	Matrix WATER	Matrix SOIL	CLIENT SAMPLE ID (9 CHARACTERS)	# OF CONTAINERS	ANALYSES REQUESTED	REMARKS	LAB 1 ID	LAB 2 ID
2/17	12:00	X		X		STARKIST	1	X	1-5gal Cubitainer on ice		

Sampled By & Title (Please sign and print name): [signature] Date/Time: 2/17/93 1300

Relinquished By (Please sign and print name): [signature] Date/Time: 2/17/93

Received By (Please sign and print name): Don Hungerford Date/Time: 2/17/93 1445

Relinquished By (Please sign and print name): [signature] Date/Time: 2/19/93 9:31

Received By (Please sign and print name): [signature] FEDEX COURIER Date/Time: 2/19/93 0930

Relinquished By (Please sign and print name): Date/Time:

Received By (Please sign and print name): Date/Time:

Shipped Via: UPS BUS Fed-Ex Hand Other ____ Shipping #:

Work Authorized By (Please sign and print name):

Remarks: Composite both 5gal cubitainers together

HAZWRAP/NESSA: Y N

QC Level: 1 2 3 Other: ____

COC Rec | ICE

Ana Req | TEMP

Cust Seal | Ph

Instructions and Agreement Provisions on Reverse Side

DISTRIBUTION: ORIGINAL - LAB, Yellow - LAB, Pink - Client

REV 11/92 FORM 340

CH2M HILL
QUALITY ANALYTICAL LABORATORIES

CHAIN OF CUSTODY RECORD AND AGREEMENT TO PERFORM SERVICES

CH2M HILL Project #:
Purchase Order #:

Project Name: StarKist/Samoa NPDES

Company Name/CH2M HILL Office: CH2M-Hill-Seattle

Project Manager & Phone #: Mr. [ ] Ms. [ ] Dr. [ ] David Wilson

Report Copy to:

Requested Completion Date:

Sampling Requirements: SDWA [ ] NPDES [X] RCRA [ ] OTHER ____

Sample Disposal: Dispose [ ] Return [ ]

LAB TEST CODES

ANALYSES REQUESTED: Bioassay

SHADED AREA -- FOR LAB USE ONLY: Lab 1 # / Lab 2 # / Quote # / Kit Request # / Project # / No. of Samples / Page / of / COC Rev / Login / LIMS Ver / Ack Gen

Sampling Date ('93)	Time	Type COMP	Type GRAB	Matrix WATER	Matrix SOIL	CLIENT SAMPLE ID (9 CHARACTERS)	# OF CONTAINERS	Bioassay	REMARKS	LAB 1 ID	LAB 2 ID
2/17	12:00	X		X		STARKIST	1 (5 gal)	X	1 5-gal cubitainer on ice		

Sampled By & Title (Please sign and print name): [signature]	Date/Time: 2/17/93 1300	Relinquished By (Please sign and print name): [signature] — Date/Time: 2/17/93 1650
Received By (Please sign and print name): [signature] Don Kingery	Date/Time: 2/17/93 1650	Relinquished By (Please sign and print name): Donald Kingery — Date/Time: 2/19/93 9:30
Received By (Please sign and print name): [signature] E. TARGGART	Date/Time: 2/19/93 0930	Relinquished By (Please sign and print name): — Date/Time:
Received By (Please sign and print name):	Date/Time:	Shipped Via: UPS BUS Fed-Ex Hand Other____ — Shipping #:
Work Authorized By (Please sign and print name):	Remarks: Samples are 24 hour composites started 2/16/93 @ 1100	

HAZWRAP/NESSA: Y N
QC Level: 1 2 3 Other: ____
COC Rec / ICE
Ana Req / TEMP
Cust Seal / Ph

Instructions and Agreement Provisions on Reverse Side

* Composite both containers together for Bioassay sample - see 2nd cooler.

DISTRIBUTION: ORIGINAL - LAB, Yellow - LAB, Pink - Client
REV 11/92 FORM 340

SUMMARY REPORT FOR AN ACUTE BIOASSAY
CONDUCTED UNDER NPDES

MEC Analytical Systems, Inc.
Bioassay Division
98 Main St #428
Tiburon, CA 94920

Client: CH2M Hill California, Inc.
1111 Broadway
Oakland, CA 94607

REPORT DATE: March 18,1993

SAMPLE AND BIOASSAY INFORMATION

PROJECT # 93014-1

TEST INFORMATION

Type: 96-Hour Acute

Concentrations (%): 1.56, 3.13, 6.25, 12.5, 25, 50, 100

Species: *Penaeus vannamei*

Common name: White Shrimp

Age: post - larval

Mean length (mm): 7.6

Mean weight (mg): 0.66

TEST PARAMETERS

 # Organisms/tank: 10

Source: Brezina & Associates
Dillon Beach, CA

Exposure volume (mL): 500

Test chamber size (mL): 1000

SAMPLE INFORMATION

Project Name: Starkist/Samoa NPDES

Sample ID: Starkist, 24 hour composite

Date Sampled: 2/16/93-2/17/93

Sample Received: 2/19/93

Test Start Date: 2/20/93

Sample Preparation: Salinity to 25ppt

Diluent: Ocean Beach Seawater at 25ppt

COMMENTS:

Ammonia levels in the effluent were very high. Un-ionized ammonia levels reached 0.215 mg/L in 100% effluent. Mortality occurred in all concentrations down to 6.25%, which had an un-ionized ammonia of 0.021 mg/L. Data for ammonia toxicity to Penaeus vannamei was unavailable, but data for other shrimp species indicate widely varying LC50s (from 0.23 to 3.41 mg/L NH3 -N).

These data implicate toxicant(s) other than ammonia. Dissolved oxygen levels were low throughout the test. Solutions were aerated 24-hours after the test began, but mortality occured in the first 24-hours of the study. To determine if low oxygen levels caused the mortality a mini-study was performed. Extra sample was used to prepare 25% and 50% concentrations; these soulutions were aerated, and organisms were placed in them. Dissolved oxygen levels were high enough to be non-toxic, but after 24-hours, 100% mortality occured. These data indicate toxicity was not due solely to low dissolved oxygen levels.

RESULTS	
LC50 (%):	4.8
95% CL	(4.3-5.2)
Method:	Spearman - Karber

NOEC (%):	3.13
METHOD: Bonferroni Adjusted t- Test	

Reference: EPA 1990 Methods for Measuring the acute toxicity of effluents to freshwater and marine organisms, Third edition. Peltier, W.H. and C.I. Weber eds. EPA, Enivironmental Monitoring and Support Laboratory, Cincinnati, OH, EPA/600/4-90/027.

Kurt F. Kline, Ph.D.	**Laura Targgart**	**Eugenia McNaughton Ph.D.**
Laboratory Director	**Study Director**	**QA Manager**

Project #: 93014

Water Quality Data

Sample	pH (units)	DO (mg/L)	Total NH3 (mg/L)	Total Cl2 (mg/L)	Initial Sal (ppt)
Effluent	6.47	2.5	40.6	0.05	12.6

Initial Water Quality:

Conc		Day 0				Day 1				Day 2				Day 3			
(%)	Rep	°C	DO	pH	Sal	°C	DO	pH	Sal	°C	DO	pH	Sal	°C	DO	pH	Sal
Control	1	20.1	9.4	7.67	25	19.7	9.3	7.67	25	19.4	8.9	7.62	25	19.1	9.0	7.58	25
Saline	1	20.3	9.6	8.10	25	19.8	9.6	8.08	25	19.6	8.9	8.10	25	19.7	9.2	8.20	25
1.56	1	20.2	9.3	7.63	25	19.4	9.3	7.68	25	19.5	8.9	7.65	25	19.8	9.2	7.77	25
3.13	1	20.1	9.4	7.67	25	20.1	9.3	7.67	25	20.5	8.9	7.65	25	19.6	9.0	7.78	25
6.25	1	20.1	9.3	7.50	25	20.3	9.2	7.67	25	20.1	8.8	7.62	25	19.6	9.0	7.63	25
12.5	1	20.2	8.8	7.38	25												
25	1	20.4	8.4	7.19	25												
50	1	20.1	7.6	7.06	25												
100	1	20.0	7.4	7.33	25												

Final Water Quality:

Conc (%)	Rep	# Init	Day 1 °C	DO	pH	Sal	# Alive	Day 2 °C	DO	pH	Sal	# Alive	Day 3 °C	DO	pH	Sal	# Alive	Day 4 °C	DO	pH	Sal	# Alive	% Survival
Control	1	10	20.3	7.5	7.62	25	10	19.3	8.0	7.83	25	10	19.9	8.2	7.88	20	10	19.7	8.3	7.97	25	10	100
	2	10	20.3	7.5	7.63	25	10	19.0	8.1	7.88	25	9	19.9	8.2	7.90	26	9	19.6	8.1	7.98	25	9	90
Saline	1	10	20.4	7.5	7.86	25	10	19.0	8.1	8.13	25	10	19.9	8.0	8.10	25	10	19.8	8.1	8.23	25	10	100
	2	10	20.3	7.5	7.90	25	10	19.0	8.2	8.14	25	10	20.0	8.3	8.10	25	10	19.8	8.1	8.30	25	10	100
1.56	1	10	20.2	4.0	7.65	25	10	19.0	8.2	7.95	25	10	20.1	8.4	7.92	26	10	20.1	8.2	7.97	25	10	100
	2	10	20.1	4.0	7.57	25	8	19.0	8.2	7.95	25	8	20.1	8.4	7.91	26	8	20.1	8.3	7.92	25	8	80
3.13	1	10	20.1	4.5	7.55	25	10	19.0	8.2	7.96	25	10	20.0	8.3	7.94	26	10	20.3	8.3	7.88	25	10	100
	2	10	20.1	4.5	7.54	25	10	19.0	8.1	7.97	25	10	20.2	8.3	7.96	26	10	20.2	8.3	7.91	25	10	100
6.25	1	10	20.1	1.6	7.26	25	1	19.0	8.2	7.97	25	1	20.1	8.1	7.88	25	1	19.8	8.2	7.68	25	1	10
	2	10	20.1	1.8	7.27	25	1	19.0	8.2	7.89	24	1	20.0	8.2	7.87	26	1	19.9	8.2	7.61	25	1	10
12.5	1	10	20.0	1.5	7.28	25	0																0
	2	10	20.0	1.5	7.28	25	0																0
25	1	10	20.1	1.0	7.25	25	0																0
	2	10	20.1	1.0	7.25	25	0																0
50	1	10	20.1	0.9	7.26	25	0																0
	2	10	20.1	0.9	7.26	25	0																0
100	1	10	20.1	0.8	7.23	25	0																0
	2	10	20.1	0.8	7.24	25	0																0

ATTACHMENT II

LABORATORY REPORT
MEC Analytical Systems, Inc
96-hour Acute Bioassay

JOINT CANNERY OUTFALL EFFLUENT SAMPLES
February 16 and 17, 1993

STARKIST SAMOA, INC. and VCS SAMOA PACKING COMPANY

Copy of each report to Mike Lee
Army Engineers

CH2M HILL
Engineers
Planners
Economists
Scientists

SEP 15 1994
RECEIVED

9 September 1994

PDX30702.EL

Patricia N.N. Young
American Samoa Program Manager
Office of Pacific Islands and Native American Programs
U.S. Environmental Protection Agency
75 Hawthorne Street (E-4)
San Francisco, California 94105

Dear Pat:

Subject: Joint Cannery Outfall Effluent Bioassay Testing

Enclosed are two copies each of Technical Memorandums describing the results of the second and third episodes of bioassay testing done under StarKist Samoa and VCS Samoa Packing NPDES permit requirements. Unless USEPA or ASEPA have specific concerns, we will continue performing the tests as described in these reports.

If you have any questions please feel free to call me at your convenience.

Sincerely,

CH2M HILL

Steven L. Costa
Project Manager

cc: Norman Wei, StarKist Seafood Company (w/o enclosures)
James Cox, Van Camp Seafood Company (w/o enclosures)
Barry Mills, StarKist Samoa, Inc. (1 copy of enclosures)
Michael Macready, VCS Samoa Packing Company (1 copy of enclosures)

CH2M HILL 1111 Broadway, P.O. Box 12681, Oakland, CA 94604-2681 510 251-2426 Fax 510 893-8205

PREPARED FOR: StarKist Samoa, Inc.
VCS Samoa Packing Company

PREPARED BY: Steve Costa/CH2M HILL/SFO
Don Kingery/CH2M HILL/SFO

DATE: 6 July 1994

SUBJECT: **Bioassay Testing of Effluent February 1994 Sampling**

PROJECT: OPE030702.EL.R3

Purpose

This memorandum presents the results of the effluent bioassay testing of the Joint Cannery Outfall effluent sample that was collected in February 1994. This is the third of the required semi-annual tests. Separate Technical Memoranda describe the results of concurrent effluent chemistry testing.

Study Objectives

Section D.1 of the StarKist Samoa and VCS Samoa Packing NPDES permits requires that semi-annual definitive acute bioassays (96-hour, static bioassays) be conducted on the cannery effluent. The purpose of these bioassays is to determine whether, and at what effluent concentration, acute toxicity may be detected for the effluent.

These bioassays were originally specified to be conducted using the white shrimp, *Penaeus vannamei* (postlarvae). In the event *Penaeus vannamei* are not available at the time of the tests substitute species have been approved by EPA (see Attachment I). *Penaeus vannamei* was available and used for this test as well as the previous tests.

The acute bioassay effluent sampling must be concurrent with effluent sampling for priority pollutant chemical analysis. Effluent samples are to be collected as 24-hour composite samples. The effluent acute bioassay was conducted using a composite effluent from both the StarKist Samoa and VCS Samoa Packing facilities, as approved by EPA. This combined effluent bioassay is representative of the wastewater discharged from the Joint Cannery Outfall.

Effluent Sampling Methods

Between 0900 on February 15th and 0700 on February 16th, 1994, a 24-hour, flow-weighted composite sample of final effluent was collected from both the StarKist Samoa and VCS Samoa Packing treatment plant discharges. Samples were collected from the established effluent sampling sites following the routine composite sample collection schedule for the plants.

A total of eight grab samples were collected into pre-cleaned 1-gallon plastic cubitainers at each plant. Samples were collected at approximately three-hour intervals over a 24 hour period. The samples were stored on ice until the completion of the 24-hour sampling period. After all samples were collected a flow-proportioned composite sample was prepared. The grab sample collection times and the relative effluent volumes calculated from plant flow records are summarized in Table 1. The relative effluent volumes were used to prepare the final composite sample, which was used to fill the sample containers shipped to the laboratory for testing.

Sample cubitainers were packed on ice in ice chests for shipment to the laboratory. Sample chain of custody forms were completed and then sealed into zip-lock bags and taped inside the lid of the ice chest. Samples were shipped as checked luggage on flights from Pago Pago to Honolulu and then to San Francisco. Samples that were composited on February 16th, were delivered to the testing laboratory on February 19th. Laboratory bioassay test reports and chain-of-custody forms are attached to this memorandum. The chain of custody forms are included in Attachment II.

Bioassay Testing Procedures

The bioassay tests were conducted by Advanced Biological Testing Inc., Tiburon, California. The testing procedures and results of the bioassay tests are provided "*Results of a Bioassay Conducted on an Effluent Sample from the Joint Cannery Outfall in American Samoa using Penaeus vannamei*" dated June 29, 1994 included as Attachment III. This report summarizes the 96-hour acute bioassay test conducted with reference to the EPA document *EPA/600/4-90/027* as the source of methods for conducting the test. The bioassay tests were also conducted considering and following EPA's comments on the first (February 1993) bioassay tests (Attachment I).

Because of the demonstrated potential for a lethal immediate dissolved oxygen demand (IDOD), discussed and documented in pervious technical memoranda describing the first two bioassay tests, each bioassay test chamber was continuously aerated for during the bioassay tests to maintain adequate levels of DO. Bioassay tests were carried out for effluent concentrations of 50, 25, 12.5, 6.25, 3, and 1.5% in seawater. Water quality

was monitored daily with parameters measured including DO, pH, salinity, and temperature. Additionally, a reference toxicant of sodium dodecyl sulfonate (SDS) was run at concentrations of 100, 50, 25, 12.5, and 6.25 μg/L in 25 ppt seawater for a 96-hour test.

Results

Effluent Bioassays. All results from the bioassay tests are included in Attachment III. The results of the bioassay tests indicate the LC50 for the effluent tested is 15.76% with mortality generally delayed until Day 2 or later. Results at the end of Day 2 indicate that the LC50 for 48 hours is greater than 50%. The No Observable Effects Concentration (NOEC) for the 96-hour bioassay was <1.6% (the least observable effects concentration, LOEC, was 1.6%).

Reference Toxicant Bioassays. The reference toxicant had a LC50 of 26.69 mg/l, a NOEC of 6.25 mg/l, an a LOEC of 12.5 mg/l.

Discussion

Table 2 summarizes the results of the effluent bioassay tests for the samples collected in February 1994 compared to the previous bioassay tests. The NOEC of ,1.6% is lower than that obtained for the previous tests (NOEC approximately 3.1%). The LC%) of 15.76% is consistent with the 15.67% LC50 from the October 1993 tests and considerable less than the 4.8% LC50 determined from the February 1993 tests.

The differences in LC50 are probably attributable to changes in test procedures. For the February 1993 tests, the water was not initially aerated, resulting in large drops in DO levels during the first day of testing (DO concentrations of less than 2 μg/l for effluent concentrations greater than 6.25%). During these tests all organism deaths for concentrations greater than 6.25% occurred within the first day. The test chambers were aerated during the remaining days of the February 1993 tests and no additional mortality was observed. During the October 1993 and the February 1994 bioassays, aeration was maintained throughout the duration of the tests.

The NOEC of <1.6% for the February 1994 tests is lower than the previous tests which resulted in NOEC levels of 3.1%. The reason for this change is unknown. Future tests will provide additional data on which an evaluation of this change can be based.

Conclusions

The laboratory test results of the previous bioassay tests for the Joint Cannery Outfall effluent are not considered to be of concern. The 96-hour LC50 is the same as that from the previous (October 1993) tests. The NOEC is lower than both previous tests. However, as discussed in the reports for the previous tests on this effluent, the time scale of the mixing of the effluent with the receiving water is on the order of seconds to achieve dilutions that will eliminate possible toxic effects as reflected by the bioassay results. For example an NOEC of 1.6% corresponds to a dilution of 63:1, which is achieve in less than a minute and within about 30 feet of the discharge. The discharge is located in about 180 feet of water. The effluent is diluted to non-toxic levels with the initial dilution plume of the discharge.

Effluent Bioassay Testing
February 1994 Sampling
StarKist Samoa/VCS Samoa Packing

Table 1
StarKist Samoa and VCS Samoa Packing 24-hour Composite Sample for Bioassay Testing
February 15-16, 1994

Grab Sample Number	VCS Samoa Packing		StarKist Samoa		VCS Samoa Packing Percent of Total Flow	StarKist Samoa Percent of Total Flow
	Sampling Time	Effluent Flow Rate (gpm)	Sampling Time	Effluent Flow Rate (gpm)		
1	0900	181	1000	1208	13	87
2	1200	417	1300	1215	26	74
3	1500	444	1600	1347	25	75
4	1800	444	1900	1222	27	73
5	2100	444	2200	1243	26	74
6	2400	472	0100	1250	27	73
7	0300	472	0400	847	36	64
8	0600	500	0700	750	40	60
Mean		422		1135	27	73

Table 2
StarKist Samoa and VCS Samoa Packing
Combined Effluent Bioassay Results

Parameter	Previous Test Results		February 1994 Test Results
	February 1993	October 1993	
LC50	4.8%[1]	15.67%	15.76%
NOEC	3.13%	3.13%	<1.6%[2]

[1] The February 1993 samples were not aerated until after the first day of the test. For subsequent tests the samples were aerated for the entire duration of the tests.
[2] The LOEC for the February 1994 tests was 1.6%.

ATTACHMENT I

MEMORANDA:

Review of Joint Cannery Outfall Effluent Bioassay Testing Results

Approval of Modifications to the Joint Cannery Outfall Study Plans: Effluent Chemistry and Bioassays

STARKIST SAMOA, INC. and VCS SAMOA PACKING COMPANY

OCT 25 1993

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

October 19, 1993

Steven L. Costa
Project Manager
CH2M Hill
P.O. Box 12681
Oakland, CA 94604-2681

Re: Approval of Modifications to the Joint Cannery Outfall Study Plans: Effluent Chemistry and Bioassays

Dear Steve:

We have reviewed the reports on the chemical analysis of effluent for VCS Samoa Packing (April 30, 1993) and StarKist Samoa (April 29, 1993), as well as the technical memorandum of May 10, 1993 on bioassay tests on the combined cannery effluent. Our comments on these reports and their recommendations are as follows:

Effluent Bioassay Tests

The first bioassay results indicated the effluent probably has a high immediate dissolved oxygen demand (IDOD) which was responsible for the observed mortality of the test organisms. We approve of the proposal to continue to use a combined cannery effluent sample as done in the first bioassay tests, and include immediate dissolved oxygen demand (IDOD) tests on these samples. The tests will then be run with sufficient aeration to support the test organisms. Parallel tests should also be run following standard procedures.

Reasonable attempts must be made to obtain *Penaeus vannamei* as the test organism. However, in the event these organisms are not available, *Mysidopsis bahia* and/or *Holmesimysis costata* may be used as substitute organisms.

Please see the attached memo from Amy Wagner of EPA's Laboratory Support Section for further comments on the results and proposed study plan.

Chemical Analysis of Effluent

The chemical analysis of the effluent revealed exceedances of ambient water quality standards for silver (StarKist) and copper and zinc (Samoa Packing). If the results of the second tests show similar exceedances, this will be cause for concern and we will require the canneries to seek the source of the metals and implement measures to reduce their discharge.

However, since dioxin and asbestos were not detected in the effluent, we are approving the request to eliminate analyses for these substances in future effluent chemical analyses.

Please call Pat Young at 415/744-1594 if you have any questions regarding the above.

Sincerely,

for Norman L. Lovelace, Chief
Office of Pacific Island and Native
American Programs (E-4)

Enclosure

cc: Jim Cox, Van Camp Seafood Company
Norman Wei, StarKist Seafood Company
Tony Tausaga, American Samoa EPA
Sheila Wiegman, American Samoa EPA

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

October 1, 1993

SUBJECT: Review of Joint Cannery Outfall Effluent Bioassay Testing results

FROM: Amy L. Wagner, P-3-1
Laboratory Support Section

THRU: Brenda Bettencourt, Chief
Laboratory Support Section

TO: Pat Young, E-4
OPINAP

I have reviewed the bioassay testing report of the Joint Cannery Outfall for StarKist Samoa and VCS Samoa Packing. The comments below summarize our discussion today.

1. The report suggests (p. 4) that a high immediate dissolved oxygen demand (IDOD) may be responsible for the toxicity testing results. However, supplementary tests still showed 100% toxicity when test containers were aerated. These results suggest toxicity in the effluent was due to factors other than low dissolved oxygen concentrations. It should be noted that the chemical analyses indicated high levels of metals. Specifically, the reported values for copper and zinc exceed some acute levels for marine invertebrates in the water quality criteria documents.

2. The manual "Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms," Fourth Edition, EPA/600/4-90/027, should be followed more closely in future tests. As stated in Table 15 (p. 64), aeration should be provided if dissolved oxygen falls below 4.0 mg/L and a renewal of the test solutions must be conducted after 48 hours. As proposed in the report, an IDOD test may be run on the effluent prior to testing.

3. Although testing is being conducted on a semi-annual basis, a reference toxicity test must also be run concurrently with the effluent toxicity test. Reference toxicity tests are stipulated in the acute toxicity testing manual (p.8) and provide information on the consistent quality of test organisms.

4. Use of the white shrimp, Penaeus vannamei should be continued. If this species is unavailable, Mysidopsis bahia would be an acceptable surrogate species since it is listed in EPA's acute toxicity testing methods manual to be mandated in the Federal

Register this year. Formal approval of this substitute organism is the responsibility of the Permits Issuance Section.

Further information regarding toxicity testing policy and permit language should be referred to the Whole Effluent Toxicity Coordinator, Debra Denton (W-7-1), at 744-1919. I have given her a copy of the permit and report. If you have any further questions, please do not hesitate to contact me at 744-1495.

cc: Debra Denton, W-7-1

ATTACHMENT II

CHAIN OF CUSTODY FORMS

JOINT CANNERY OUTFALL EFFLUENT SAMPLES
February 15 and 16, 1994

STARKIST SAMOA, INC. and VCS SAMOA PACKING COMPANY

CH2M HILL

QUALITY ANALYTICAL LABORATORIES

CHAIN OF CUSTODY RECORD AND AGREEMENT TO PERFORM SERVICES

CH2M HILL Project #	Purchase Order #
Project Name: JCO Effluent Composite – Bioassay	
Company Name/CH2M HILL Office: SFO	
Project Manager & Phone # (510) 251 2848 x 2251 Mr. [ ] Ms. [ ] Dr. [x] Steve Costa	Report Copy to:
Requested Completion Date:	Sampling Requirements: SDWA ☐ NPDES ☒ RCRA ☐ OTHER ___
	Sample Disposal: Dispose ☐ Return ☐

LAB TEST CODES

ANALYSES REQUESTED: Bioassay

SHADED AREA FOR LAB USE ONLY: Lab 1 # / Lab 2 # / Quote # / Kit Request # / Project # / No. of Samples / Page / COC Rev / LIMS Ver / Ack Gen

Sampling Date	Sampling Time	Type: COMP	Type: GRAB	Matrix: WATER	Matrix: SOIL	CLIENT SAMPLE ID (9 CHARACTERS)	# OF CONTAINERS	Bioassay	REMARKS	LAB 1 ID	LAB 2 ID
2/16	1300	X		X		JCO-EFF	1	X			

Sampled By & Title (Please sign and print name): Donald L. Kingery, Engineer	Date/Time: 2/16/94 1400	Relinquished By (Please sign and print name)	Date/Time
Received By (Please sign and print name): Steven L Costa	Date/Time: 2/18/94 1730	Relinquished By (Please sign and print name)	Date/Time
Received By (Please sign and print name): Kurt F. Kline	Date/Time: 2/19/94	Relinquished By (Please sign and print name): S. Costa	Date/Time
Received By (Please sign and print name)	Date/Time	Shipped Via: UPS BUS Fed-Ex Hand Other___	Shipping #
Work Authorized By (Please sign and print name)	Remarks		

HAZWRAP/NESSA: Y N / QC Level: 1 2 3 Other: / COC Rec / ICE / Ana Req / TEMP / Cust Seal / Ph

Instructions and Agreement Provisions on Reverse Side

DISTRIBUTION: ORIGINAL - LAB, Yellow - LAB, Pink - Client

REV 11/92 FORM 340

CHAIN OF CUSTODY INSTRUCTIONS

CH2M HILL Project #:	CH2M HILL project number to be charged for work.
Purchase Order #:	Purchase order to be charged for work (OTC clients).
Project Name:	Name of project which the samples support.
Company Name/CH2M HILL Office:	Name of the company or CH2M HILL office requesting the work. Correspondence will be sent to the company address or CH2M HILL office.
Project Manager & Phone #:	Name and phone number of person who receives the laboratory report and can be contacted if questions arise.
Report Copy To:	Name and location of person to receive copy of laboratory report.
Requested Completion Date:	When the report is required. Normal Turnaround Time (TAT) = 23 days (30 days for Hazwrap C/D or CLP). Faster TAT must be prearranged through Client Services.
Sampling Requirements:	Program under which sampling and analysis are to be performed.
Sample Disposal:	Indicate whether the samples are to be returned to the project manager or disposed by the laboratory.
Sampling:	The date and time at which the sample was collected.
Type:	Indicate the type of sample (composite or grab) collected.
Matrix:	Indicate the sample matrix (water or soil).
Client Sample ID:.	Identifier assigned by the project to uniquely identify the samples (must not exceed nine (9) characters).
Number of Containers:	The number of different containers for this line item or sample.
Analyses Requested:	Use one column for each parameter or group of parameters. Specific method numbers, parameter list, and TIC's should be indicated.
For Lab Use Only:	Do not mark in the shaded area.
Remarks:	Record any comments about each sample on the same line as the sample description, e.g., "Wastewater contains VOC's." Known high concentrations should be noted.
Sampled by and Title:	The person who took the sample signs this box and prints his/her name, title, date, and time when sampling was completed.
Relinquished By:	The sampler signs this box and prints his/her name, date, and time when the samples are given to someone else.
Received By:	The person who receives the samples signs here and prints his/her name, date, and time when the samples were accepted into his/her custody.
Sample Shipped Via:	How the samples are being shipped to the laboratory, e.g., "Fed Ex."
Air Bus Bill Number:	The number on the shipping papers by which the package can be traced.
Work Authorized By:	Printed name and signature of person authorizing the initiation of laboratory work.
Remarks:	Record any comments regarding the samples as a whole. Additional parameters or special requirements should be indicated.

PROVISIONS

1. **Authorization to Proceed**
   Execution of this Agreement and Chain of Custody by the CLIENT will be authorization for CH2M HILL to proceed with the Laboratory work.

2. **Compensation and Terms of Payment**
   For services described on this Chain of Custody, CH2M HILL Quality Analytical Laboratories will be compensated based on a written quotation or the standard rates per analysis contained in our published price guide. Invoices will be issued by laboratories as services are completed. Invoices are due and payable upon receipt. Interest at the rate of 1-1/2 percent per month, or that permitted by law if lesser, may be charged on past due amounts starting 30 days after date of invoice. Payments will first be credited to interest and then to principal. The prices stated in a written quotation or on the price guide schedule do not include sales or other taxes. Such taxes, when applicable, will be added to the invoice. Unless otherwise specified, the minimum invoice is $100.00. CH2M HILL Quality Analytical Laboratories reserve the right to change prices published in our price guide without notice.

3. **Standard of Care**
   The standard of care applied to our environmental laboratory services will be the degree of skill and diligence normally employed by laboratory industry personnel performing the same or similar service.

4. **Warranty and Limitation of Liability**
   CH2M HILL Quality Analytical Laboratories make no warranty, express or implied, and under no circumstances will be liable for any claims or damages except those resulting solely from their own or their employees' negligence. To the maximum extent permitted by law, our liability for damages will not exceed the compensation received by CH2M HILL Quality Analytical Laboratories under the project Agreement.

5. **Severability and Survival**
   If any of the provisions contained in this Agreement are held illegal, invalid or unenforceable, the enforceability of the remaining provisions shall not be impaired thereby. Limitations of liability and indemnities shall survive termination of this Agreement for any cause.

6. **Asbestos or Hazardous Substances**
   To the maximum extent permitted by law, the CLIENT will indemnify and defend CH2M HILL and its officers, employees, subconsultants, and agents from all claims, damages, losses, and expenses, including, but not limited to, direct, indirect, or consequential damages and attorney's fees in excess of the Limitation of Liability in **Article 4** arising out of or relating to the presence, discharge, release, or escape of hazardous substances, contaminants, or asbestos on or from the Project.

7. **Interpretation**
   The limitations of liability and indemnities will apply whether CH2M HILL's liability arises under breach of contract or warranty; tort, including negligence (but not sole negligence); strict liability; statutory liability; or any other causes of action; and shall apply to CH2M HILL's officers, employees, and subcontractors. The professional services agreement will take precedence in the event there is a conflict with the agreement and chain-of-custody document.

8. **Sample Disposal and Storage**
   Disposal of hazardous waste samples is the responsibility of the CLIENT, unless disposal agreements are made. Hazardous waste samples will be returned 30 days after the submission of the analytical report, or disposed of at a rate of $25 per sample. For large projects and upon special request, samples may be stored for longer than 30 days at a rate of $5/month per sample.

ATTACHMENT III

LABORATORY REPORT
Advanced Biological Testing
96-hour Acute Bioassay

JOINT CANNERY OUTFALL EFFLUENT SAMPLES
February 15 and 16, 1994

STARKIST SAMOA, INC. and VCS SAMOA PACKING COMPANY

RESULTS OF A BIOASSAY CONDUCTED ON AN EFFLUENT SAMPLE FROM THE JOINT CANNERY OUTFALL IN AMERICAN SAMOA USING *Penaeus vannami*

Prepared for:

CH2M Hill California, Inc.
1111 Broadway
Oakland, CA 94607
Project # PDX 30702

Prepared by:

Advanced Biological Testing Inc.
98 Main St., # 419
Tiburon, Ca. 94920

June 29, 1994

Ref: 9309-2

1.0 INTRODUCTION

At the request of CH2M Hill (Project # PDX 30702), Advanced Biological Testing conducted a four day effluent bioassay test on *Penaeus vannami* using effluents collected from the joint cannery outfall at the Starkist and Van Camp tuna canneries in American Samoa. The study was run using methods generally specified in EPA 1991.

The study was conducted at the Advanced Biological Testing Laboratory in Tiburon, California, and was managed by Mr. Mark Fisler.

2.0 METHODS

2.1 EFFLUENT SAMPLING

The effluents were sampled on February 16, 1994 by personnel from CH2M Hill. Due to shipping and airline scheduling problems, frequently encountered in this region, the sample was received by the laboratory on February 19, 1994. One five gallon carboy was provided, maintained in ice-filled coolers from the date of sampling until laboratory receipt. The sample were at 2-3°C upon receipt.

2.2 SAMPLE PREPARATION

The effluents were tested at the concentration series of 50, 25, 12.5, 6.25, 3.1, and 1.6% as vol:vol dilutions in seawater. The diluent was filtered seawater from the Bodega Bay Marine Laboratory. The effluent salinity was 12 ppt, while the Bodega seawater was 34 ppt. The highest dilution yielded a salinity of 25 ppt, which was within the physiological range of the test species and the test was then run at that salinity. The control was Bodega Bay seawater diluted with spring water to 25 ppt. The dilutions were brought up to the test temperature (20°C) and aerated continuously. Based upon data provided by CH2M Hill, and subsequently supported by information from the EPA, these effluents have an increasing biological oxygen demand, with a significant peak at 10-14 hours after test initiation. Previous testing of this effluent without initial aeration demonstrated significant toxicity at 24 hours (or before); therefore aeration was carried out from the beginning of the test.

A reference toxicant was run using concentrations provided by the EPA. The toxicant was sodium dodecyl sulfonate (SDS) made up as a 2 grams per liter stock solution in distilled water. The tested concentrations were set at 100, 50, 25, 12.5, and 6.25 mg/L in 25 ppt seawater in a 96 hour test.

2.3 TESTING PROCEDURES

The bioassay was carried out on P-5 post-larvae of *Penaeus vannami*, supplied by J. Brezina and Associates. in Dillon Beach, California. The animals were air-shipped and were received at ABT on February 19, 1994. The test conditions are summarized in Tables 1 and 2. Five replicates of each concentration were tested with ten post-larval shrimp per replicate. Water quality was

monitored daily as initial quality on Day 0 and final water quality on Days 1-4. Parameters measured included dissolved oxygen, pH, salinity, total ammonia, and temperature.

2.4 STATISTICAL ANALYSIS

At the conclusion of the test, the survival data were evaluated statistically using ToxCalc™ to determine ECp, NOEC, and TU values where appropriate. ToxCalc™ is a comprehensive statistical application that follows standard guidelines for acute and chronic toxicity data analysis.

Statistical effects can be measured by the ECp, the estimated concentration that causes any effect, either lethal (LC) or sublethal (IC), on p% of the test population. The LCp is the point estimate of the concentration at which a lethal effect is observed in p% of the test organisms. ECp values include 95% confidence limits if available.

The NOEC (No Observable Effect Concentration) is the highest tested concentration at which mortality and other sublethal measured effects are not significantly different from the same parameters in the control.

TU (Toxicity Units) are calculated as 100%/NOEC.

3.0 RESULTS

The results of the bioassay and the water quality monitoring are presented in Tables 2 through 6. Water quality measurements were within the acceptable limits provided in EPA 1991. Temperature was maintained at 20 ± 2°C; pH remained relatively stable, and the salinity increased slightly as would be expected in a static test (Tables 1 and 2). The dissolved oxygen did drop as projected at approximately 14 hours after test initiation in the highest concentration (50%), even with aeration. Aeration was maintained in all chambers for the duration of the test. Ammonia was measured in the 100% effluent and was greater than 30 ppm.

The LC50 for the effluent was 15.76%. Mortality in the effluent was generally delayed until Day 2 or later. There was significant mortality at 50, 25, 12.5 and 6.25% concentrations compared to the control. The NOEC was <1.6% and the LOEC was 1.6%.

The reference toxicant test had an LC50 of 26.69 mg/L, an NOEC of 6.25 mg/L, and an LOEC of 12.5 mg/L.

TABLE 1

Penaeus vannami

WATER QUALITY MEASUREMENTS FOR EFFLUENT TEST

Concentration		Day 0					Day 1					Day 2					Day 3					Day 4				
(ppm)	Rep	pH	DO	NH3	°C	Sal	pH	DO	NH3	°C	Sal	pH	DO	NH3	°C	Sal	pH	DO	NH3	°C	Sal	pH	DO	NH3	°C	Sal
Control	1	7.93	6.2	<0.01	19.6	32	8.08	5.4	<0.01	20.6	32	8.14	5.4		20.7	33	8.17	5.4	0.013	20.2	33	8.04	5.9	NT	21.2	NT
	2						8.12	5.2		20.6	32	8.18	5.4	0.014	20.8	33	8.18	5.3		20.2	33	8.14	5.8		21.1	
	3						8.13	5.3		20.6	32	8.18	5.4		20.9	33	8.14	5.4		20.2	33	8.13	5.7		21.2	
	4						8.05	5.2		20.5	32	8.00	5.4		20.7	33	8.17	5.4		20.1	33	7.92	5.6		21.1	
	5						8.14	5.2		20.5	32	8.17	5.3		20.7	33	8.17	5.4		20.1	33	8.16	5.3		20.9	
1.6	1	7.92	6.0	0.14	19.8	32	8.14	5.3	0.15	20.6	32	8.17	5.4		20.8	33	8.18	5.2	0.12	20.1	33	8.15	5.6	NT	21.4	NT
	2						7.97	5.2		20.6	32	8.02	5.4	0.085	20.8	33	8.19	5.4		20.2	33	7.98	5.6		21.4	
	3						8.14	5.2		20.6	32	8.16	5.4		20.9	33	8.20	5.3		20.1	33	8.18	5.6		21.3	
	4						8.16	5.2		20.6	32	8.19	5.4		20.9	33	8.19	5.3		20.1	33	8.13	5.4		21.2	
	5						8.15	5.2		20.6	32	8.19	5.4		20.8	33	8.19	5.4		20.1	33	8.18	5.5		21.2	
3.1	1	7.86	5.8	0.20	19.7	32	8.09	5.3	0.34	20.6	32	8.13	5.4		20.6	33	8.17	5.4	0.21	20.1	33	8.12	4.8	NT	21.4	NT
	2						8.14	5.2		20.6	32	8.17	5.4	0.190	20.6	33	8.16	5.5		20.2	33	8.19	4.9		21.4	
	3						8.15	5.2		20.6	32	8.19	5.4		20.7	33	8.17	5.4		20.2	33	8.19	4.8		21.3	
	4						8.14	5.2		20.6	32	8.19	5.4		20.7	33	8.20	5.4		20.1	33	8.19	4.8		21.2	
	5						8.17	5.3		20.5	32	8.21	5.4		20.6	33	8.20	5.5		20.1	33	8.21	4.8		20.9	
6.25	1	7.88	5.6	0.32	19.6	31	8.15	5.3	0.44	20.4	32	8.19	5.4		20.4	33	8.18	5.2	0.42	20.1	33	8.21	4.9	NT	21.9	NT
	2						8.09	5.2		20.2	32	8.16	5.4	0.323	20.4	33	8.18	5.1		20.1	33	8.11	3.6		21.3	
	3						8.14	5.3		20.3	32	8.19	5.4		20.5	33	8.17	5.0		20.2	33	8.19	3.4		21.2	
	4						7.88	5.3		20.3	32	8.08	5.4		20.6	33	8.19	5.1		20.1	33	8.08	3.4		21.1	
	5						8.07	5.2		20.4	32	8.13	5.3		20.6	33	8.19	5.1		20.1	33	8.16	3.2		21.1	
12.5	1	7.78	5.8	0.52	19.6	30	8.08	5.2	0.78	20.9	31	8.17	5.4		20.9	33	8.17	5.1	0.87	20.1	33	8.20	3.5	NT	21.3	NT
	2						8.06	5.2		20.7	31	8.16	5.4	0.745	21.0	33	8.18	5.2		20.1	33	8.20	3.4		21.4	
	3						8.02	5.2		20.7	31	8.13	5.4		20.9	33	8.18	5.2		20.1	33	8.17	3.4		21.4	
	4						8.07	5.2		20.7	31	8.13	5.4		20.9	33	8.17	5.1		20.1	33	8.21	3.3		21.3	
	5						8.11	5.2		20.7	31	8.18	5.4		20.9	33	8.21	5.1		20.1	33	8.21	3.3		21.3	
25	1	7.78	5.6	1.02	20.2	28	8.06	5.2	1.51	20.8	28	8.13	5.4		21.1	30	8.20	5.1	1.59	20.1	33	8.21	3.4	NT	21.4	NT
	2						8.04	5.2		20.9	28	8.15	5.4	1.51	21.1	30	8.19	5.2		20.2	33	8.21	3.3		21.5	
	3						8.02	5.2		20.9	28	8.13	5.3		21.1	30	8.19	5.2		20.2	33	8.21	3.2		21.6	
	4						8.11	5.1		20.9	28	8.20	5.3		21.1	30	8.17	5.1		20.1	33	8.25	3.2		21.5	
	5						8.20	5.2		20.9	28	8.23	5.3		21.0	30	8.17	5.0		20.1	33	8.25	3.2		21.3	
50	1	7.55	5.4	2.02	20.2	23	8.08	5.2	2.78	20.9	26	8.22	5.4		21.2	25	8.18	5.0	2.87	20.1	33	8.26	3.6	NT	21.5	NT
	2						8.13	5.1		20.9	26	8.28	5.4	2.59	21.2	25	8.23	5.0		20.1	33	8.29	3.4		21.5	
	3						8.21	5.1		21.0	26	8.30	5.3		21.2	25	8.21	5.1		20.2	33	8.30	3.3		21.5	
	4						8.24	5.1		21.0	26	8.32	5.3		21.1	25	8.20	4.9		20.2	33	8.28	3.3		21.3	
	5						8.21	5.2		20.9	26	8.31	5.3		21.0	25	8.19	5.0		20.2	33	8.30	3.3		21.3	
Min		7.55	5.4	<0.01	19.6	23	7.88	5.1	<0.01	20.2	26	8.00	5.3	0.01	20.4	25	8.14	4.9	0.01	20.1	33	7.92	3.2		20.9	
Max		7.93	6.2	2.02	20.2	32	8.24	5.4	2.78	21.0	32	8.32	5.4	2.59	21.2	33	8.23	5.5	2.87	20.2	33	8.30	5.9		21.9	

Note: NT = Not Taken.

TABLE 2

Penaeus vannami
SURVIVAL DATA FOR EFFLUENT TEST

Concentration (%)	Rep	Initial Added	Day 1	Day 2	Day 3	Day 4	% Survival	Average % Survival
Control	1	10	10	9	9	9	90	
	2	10	10	9	9	9	90	
	3	10	10	10	10	9	90	
	4	10	10	10	10	10	100	
	5	10	10	10	10	9	90	92.0
1.6	1	10	10	10	10	9	90	
	2	10	9	9	9	9	90	
	3	10	10	8	8	6	60	
	4	10	10	8	8	6	60	
	5	10	10	10	9	7	70	74.0
3.1	1	10	10	8	8	6	60	
	2	10	10	10	9	7	70	
	3	10	10	8	7	7	70	
	4	10	10	9	7	7	70	
	5	10	10	10	9	4	40	62.0
6.25	1	10	9	9	8	7	70	
	2	10	10	9	7	6	60	
	3	10	10	10	8	6	60	
	4	10	9	9	7	6	60	
	5	10	10	9	8	6	60	62.0
12.5	1	10	9	9	8	5	50	
	2	10	10	10	8	6	60	
	3	10	10	10	7	6	60	
	4	10	10	9	8	6	60	
	5	10	10	10	8	4	40	54.0
25	1	10	10	8	7	5	50	
	2	10	10	8	7	4	40	
	3	10	10	10	8	6	60	
	4	10	10	7	5	5	50	
	5	10	10	9	7	5	50	50.0
50	1	10	8	7	5	4	40	
	2	10	10	8	4	2	20	
	3	10	10	9	6	0	0	
	4	10	10	7	4	1	10	
	5	10	10	9	6	2	20	18.0

TABLE 3

Penaeus vannami
WATER QUALITY MEASUREMENTS
FOR REFERENCE TOXICANT (S.D.S) TEST

Concentration		Day 0				Day 1				Day 2				Day 3				Day 4			
(mg/L)	Rep	pH	DO	°C	Sal	pH	DO	°C	Sal	pH	DO	°C	Sal	pH	DO	°C	Sal	pH	DO	°C	Sal
Control	1	7.98	5.6	20.9	32.0	7.68	5.4	21.6	33.0	7.80	3.2	21.7	33.5	7.82	3.9	21.2	33.4	7.81	3.4	20.7	33.7
	2					7.72	5.3	21.5	33.0	7.76	3.3	21.8	33.2	7.81	3.9	21.2	33.4	7.79	3.5	20.7	33.7
	3					7.53	5.4	21.6	33.0	7.79	3.2	21.9	33.2	7.80	3.9	21.2	33.3	7.74	3.4	20.8	33.8
6.25	1	7.99	5.6	21.2	31.0	7.04	4.2	21.6	33.0	7.77	3.3	21.8	33.1	—	—	—	—	—	—	—	—
	2					7.32	4.1	21.6	33.0	7.75	3.3	21.8	33.1	7.76	3.9	21.2	33.4	7.72	3.2	20.7	33.8
	3					7.17	4.2	21.6	33.0	7.71	3.2	21.8	33.2	7.75	3.8	21.0	33.4	7.64	3.2	20.7	33.4
12.5	1	8.00	5.6	21.2	31.0	7.04	4.1	21.6	33.0	7.70	3.2	21.7	33.0	7.73	3.4	21.1	33.4	7.61	3.0	20.7	33.4
	2					7.08	4.1	21.5	33.0	7.72	3.1	21.7	33.1	7.73	3.5	21.1	33.4	7.59	3.1	20.7	33.7
	3					7.09	4.1	21.6	33.0	7.73	3.1	21.8	33.0	7.76	3.4	21.2	33.2	7.58	2.9	20.7	33.4
25	1	8.00	5.5	21.2	32.0	7.04	3.9	21.5	33.0	7.68	3.2	21.6	32.9	7.78	3.2	21.1	33.1	7.42	3.0	20.8	33.6
	2					7.04	3.7	21.6	33.0	7.65	3.2	21.7	33.0	7.77	3.2	21.1	33.4	7.53	3.1	20.8	33.8
	3					7.02	3.7	21.5	33.0	7.65	3.0	21.6	32.8	7.78	3.4	21.0	33.2	7.49	3.0	20.8	33.7
50	1	8.01	5.5	21.1	32.0	7.00	3.4	21.5	33.0	7.46	1.6	21.4	33.1	7.90	3.2	20.9	33.4	7.40	3.0	20.7	33.6
	2					7.02	3.2	21.5	33.0	7.49	1.6	21.6	33.1	7.69	3.1	20.9	33.2	7.39	3.0	20.7	33.7
	3					7.03	3.2	21.5	33.0	7.52	1.8	21.6	32.8	—	—	—	—	—	—	—	—
100	1	8.01	5.5	21.4	32.0	7.04	3.0	21.5	33.0	7.49	1.2	21.8	33.1	—	—	—	—	—	—	—	—
	2					7.02	3.0	21.6	33.0	7.38	1.3	21.8	33.0	—	—	—	—	—	—	—	—
	3					7.10	3.1	21.6	33.0	—	—	—	—	—	—	—	—	—	—	—	—
Min		7.98	5.5	20.9	31.0	7.00	3.0	21.5	33.0	7.38	1.2	21.4	32.8	7.69	3.1	20.9	33.1	7.39	2.9	20.7	33.4
Max		8.01	5.6	21.4	32.0	7.72	5.4	21.6	33.0	7.80	3.3	21.9	33.5	7.90	3.9	21.2	33.4	7.81	3.5	20.8	33.8

Note: — = All animals dead.

TABLE 4

Penaeus vannami

SURVIVAL DATA FOR REFERENCE TOXICANT (S.D.S.) TEST

Concentration (mg/L)	Rep	Initial Added	Day 1	Day 2	Day 3	Day 4	% Survival	Average % Survival
Control	1	10	10	10	10	10	100	
	2	10	10	10	9	9	90	
	3	10	10	10	10	10	100	96.7
6.25	1	10	10	10	10	10	100	
	2	10	10	10	10	10	100	100.0
12.5	1	10	10	10	8	8	80	
	2	10	10	10	7	7	70	
	3	10	10	10	8	8	80	76.7
25	1	10	8	8	6	6	60	
	2	10	10	7	7	7	70	
	3	10	10	8	8	7	70	66.7
50	1	10	5	1	1	1	10	
	2	10	6	0	—	—	0	
	3	10	6	4	2	3	30	13.3
100	1	10	0	—	—	—	0	
	2	10	1	0	—	—	0	
	3	10	1	0	—	—	0	0.0

Note: — = All animals dead.

TABLE 5

Penaeus vannami
SUMMARY OF RESULTS

(Effluent) Concentration (%)	% Survival	ECp (%)		NOEC (%)	LOEC (%)
Control	92.0	EC50	15.76 (9.18-27.98)	<1.6	1.6
1.6	74.0*				
3.1	62.0*				
6.25	62.0*				
12.5	54.0*				
25	50.0*				
50	18.0*				

Reference Toxicant Concentration SDS (mg/L)	% Survival	ECp (mg/L)		NOEC (mg/L)	LOEC (mg/L)
Control	96.7	EC50	26.69 (21.1-32.47)	6.25	12.5
100	100.0				
250	76.7*				
500	66.7*				
750	13.3*				
1000	0.0*				

* Statistically significant.
ICp/LCp: Inhibition/Lethal Concentration for p% of the organisms.
NOEC: No Observable Effect Concentration.
TU: 100%/NOEC.

TABLE 6

Bioassay Procedure And Organism Data For the Survival Bioassay Using *Penaeus vannami* (U.S. EPA 1991)

Parameter	Data
Test Species	*Penaeus vannami*
Supplier	J. Brezina and Associates
Collection location	Kahuku, Hawaii
Date Acquired	2/19/94
Acclimation Time	overnight
Acclimation Water	Shipping water
Acclimation Temperature	20±2°C
Age group	P-5 post larvae
Sample Identification	
Sample ID(s)	931020-2
Date Sampled	2/16/94
Date Received at ABT	2/19/94
Volume Received	Ten gallons
Sample Storage Conditions	4°C in the dark
Test Procedures	
Type; Duration	Acute, static/renewal at 48 hours
Test Dates	2/19/94 to 2/23/94
Control Water	Bodega Bay seawater
Test Temperature	20 ± 2°C
Test Photoperiod	14 L : 10 D
Salinity	25 ppt
Test Chamber	250 mL beakers
Animals/Replicate	10 animal/replicate
Exposure Volume	200 mL of effluent concentration and diluent
Replicates/Treatment	5
Feeding	Brine shrimp (24 hr old nauplii)
Deviations from procedures	None

4.0
REFERENCES

U.S. EPA. 1991. Methods for measuring acute toxicity of effluents to freshwater and marine organisms, 4th ed. EPA 600/4-90/027, September, 1991.

TECHNICAL MEMORANDUM CH2M HILL

PREPARED FOR: StarKist Samoa, Inc.

PREPARED BY: David Wilson/CH2M HILL/SEA
Steve Costa/CH2M HILL/SFO

DATE: 29 April 1993

SUBJECT: **Chemical Analysis of Effluent**
February 1993 Sampling

PROJECT: PDX30702.EL.R1

Purpose

This memorandum presents the results of the chemical analyses of StarKist Samoa effluent samples that were collected in February 1993.

Study Objectives

Section D.2 of StarKist Samoa's NPDES permit requires that semiannual priority pollutant analyses be conducted on the cannery effluent concurrently with bioassay tests. Effluent priority pollutant analyses includes those chemical constituents listed in 40 CFR 401.15. Each effluent sampling event must coincide with effluent sampling for acute biomonitoring. Effluent samples are to be collected as composite samples. The purpose of these analyses is to identify the chemicals present in the effluent, and provide data to determine whether the wastewater discharge complies with ambient water quality standards.

Methods

Between 0900 on February 16th and 0900 on February 17th, 1993, a 24-hour, flow-weighted composite sample of final effluent was collected from the StarKist Samoa treatment plant discharge to the surge tank. Table 1 lists the chemical analyses, method detection limits, sample holding times, sample containers, and sample preservations for these effluent samples. Effluent composite samples were collected simultaneously for chemistry and bioassay analyses.

Samples were collected from the established effluent sampling site following the routine composite sample collection schedule for the plant. A total of eight individual grab

samples were collected into pre-cleaned glass containers at three-hour intervals over a 24 hour period. The samples were stored on ice until the completion of the 24-hour sampling period, and then a flow-weighted composite sample was prepared. The grab sample collection times and the composite volumes calculated from StarKist Samoa's flow records are summarized in Table 2. These flow records were used to prepare the final composite sample, which was used to fill the sample containers.

Samples for volatile organic analysis were collected as discrete grab samples into three 40-ml vials. Four separate sets of volatile grabs were collected and shipped. The first grab set was analyzed and the other three sample vial sets were held for confirmation if required. Table 2 indicates times of discrete grab samples for volatile organic analysis.

Sample containers were wrapped in bubble-wrap, placed in zip-lock bags, and packed on ice for shipment to the laboratory. Sample chain of custody forms were completed and then sealed into zip-lock bags and taped inside the lid of the ice chest. Samples were shipped as checked luggage on flights from Pago Pago to Honolulu and then to Seattle. Samples that were composited on February 17th, were delivered to North Creek Analytical Laboratory before 1200 on February 19th.

Results

Complete laboratory data sets, laboratory quality control data reports, and chain-of-custody forms are attached to this memorandum. The chain-of-custody form is included in Attachment 1 and analytical data sheets and quality control data reports are included as Attachment 2.

The analyses conducted detected few chemical parameters in effluent from StarKist Samoa. A total of 3 inorganics, 2 semivolatile organics, and 2 volatile organics were detected: arsenic, silver, zinc, phenol, 4-methylphenol, acetone, and bromoform. The analyses for cyanide, 2,3,7,8-TCDD/TCDF (dioxin/furan), and asbestos all showed no detections. It is recommended that effluent analyses for dioxin/furans and asbestos be eliminated in future testing.

Table 1
Effluent Sample Analyses and Handling Procedures

Chemical Parameter	Analytical Method	Reporting Detection Limits	Sample Holding Time	Sample Container	Sample Preservation
Volatile Organics	EPA 8240/8260	2-10 ug/l	14 days	40 ml vial	4 deg. C (no head space)
Semivolatile Organics	EPA 8270	2-50 ug/l	7 days	1-liter amber glass	4 deg. C
Pesticides/PCB's	EPA 8080	0.01 - 10 ug/l	7 days	1-liter amber glass	4 deg. C
2,3,7,8-TCDD/TCDF	NCASI Method 551	1-10 ng/l	7 days	1-liter amber glass	4 deg. C
Total Cyanide	EPA 335	10 ug/l	14 days	1-liter plastic	5 ml NaOH
Asbestos	Polar Light Microscopy	N/A	None	500 ml plastic	None
Inorganics			6 months	500 ml plastic	5 ml, 2N HNO_3
Antimony	EPA 6010	100 ug/l			
Arsenic	EPA 7060	5 ug/l			
Beryllium	EPA 6010	10 ug/l			
Cadmium	EPA 6010	5 ug/l			
Chromium	EPA 6010	20 ug/l			
Copper	EPA 6010	10 ug/l			
Lead	EPA 7421	2 ug/l			
Mercury	EPA 7470 Modified	100 ug/l			
Nickel	EPA 6010	50 ug/l			
Selenium	EPA 6010	100 ug/l			
Silver	EPA 7760	20 ug/l			
Thallium	EPA 6010	100 ug/l			
Zinc	EPA 6010	40 ug/l			

Table 2
Effluent Chemistry 24-hour Composite Sample Collection at StarKist Samoa

Grab Sample No.	Sampling Time and Date	Effluent Flow Rate (gpm)	Percent of Total Flow	Volume Composited per 1-liter Sample (ml)
1	1100, 2/16/93	950	14.2	142
2*	1400, 2/16/93	800	12.0	120
3*	1700, 2/16/93	800	12.0	120
4	2000, 2/16/93	800	12.0	120
5	2300, 2/16/93	800	12.0	120
6	0200, 2/17/93	850	12.7	127
7*	0500, 2/17/93	850	12.7	127
8*	0800, 2/17/93	825	12.4	124

* Grab sample for volatile organics analysis also taken.

ATTACHMENT I

CHAIN OF CUSTODY FORMS

STARKIST SAMOA EFFLUENT SAMPLE
February 16-17, 1993

CH2M HILL
QUALITY ANALYTICAL LABORATORIES

CHAIN OF CUSTODY RECORD AND AGREEMENT TO PERFORM SERVICES

CH2M HILL Project #:
Purchase Order #:

Project Name: Starkist ~~AP~~ SDC Samoa Inc

Company Name/CH2M HILL Office: CH2M Hill

Project Manager & Phone #: Mr. [ ] Ms. [ ] Dr. [ ] David Wilson

Report Copy to:

Requested Completion Date:

Sampling Requirements: SDWA ☐ NPDES ☐ RCRA ☐ OTHER ____

Sample Disposal: Dispose ☐ Return ☐

LAB TEST CODES

ANALYSES REQUESTED: VOC * | Semi Vol | Pest/PCB's | Dioxin | Total Cyanide | Asbestos | Metals

SHADED AREA – FOR LAB USE ONLY: Lab 1 # | Lab 2 # | Quote # | Kit Request # | Project # | No. of Samples | Page of | COC Rev | Login | LIMS Ver | Ack Gen

Date ('93)	Time	Type COMP	Type GRAB	Matrix WATER	Matrix SOIL	CLIENT SAMPLE ID (9 CHARACTERS)	# OF CONTAINERS	VOC *	Semi Vol	Pest/PCB's	Dioxin	Total Cyanide	Asbestos	Metals	REMARKS	LAB 1 ID	LAB 2 ID
2/16	1400		X			ST-01	3	X							3020660 40ml vials w HCl		
2/16	1645		X			ST 02	3	X							Hold**		
2/17	05X		X			ST 03	3	X							Hold***		
2/17	033		X			ST 04	3	X							Hold***		
2/17	1200	X				ST	3		X						1l Amber Glass		
↓	↓	X				ST	3			X							
		X				ST	3				X						
		X				ST	3					X			1l Poly w NaOH		
		X				ST	1						X		500ml Poly		
		X				ST	1							X	500ml Poly w HNO3		

Sampled By & Title (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name)	Date/Time	HAZWRAP/NESSA: Y N
[signature]	2/17/93 ellw	[signature]	2/17/93 1700	QC Level: 1 2 3 Other:
Received By (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name)	Date/Time	COC Rec / ICE
[signature]		[signature]	2-19-93	Ana Req / TEMP
Received By (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name)	Date/Time	Cust Seal / Ph
B Neely BETH NEELY	11:55 02 19 93			
Received By (Please sign and print name)	Date/Time	Shipped Via: UPS BUS Fed-Ex Hand (Other) AIR cargo	Shipping #	
Work Authorized By (Please sign and print name)	Remarks: VOC's outgassing during collection - some gas bubbles unavoidable, others are 24 hr composite samples collection started 2/16/93			

Instructions and Agreement Provisions on Reverse Side

DISTRIBUTION: ORIGINAL - LAB, Yellow - LAB, Pink - Client

REV 11/92 FORM 340

ATTACHMENT II

LABORATORY DATA REPORT
North Creek Analytical Laboratory
Enseco-CAL, and Med-Tox Northwest

STARKIST SAMOA EFFLUENT SAMPLE
February 16-17, 1993

NORTH CREEK ANALYTICAL

18939 120th Avenue N.E., Suite 101• Bothell, WA 98011-2569
Phone (206) 481-9200 • FAX (206) 485-2992

CH2M Hill	Client Project ID:	Starkist, Samoa Inc.	Sampled:	Feb 17, 1993
777 108th Avenue NE	Sample Descript:	Water, ST	Received:	Feb 19, 1993
Bellevue, WA 98009	Analysis Method:	EPA 8270	Extracted:	Feb 23, 1993
Attention: David Wilson	Sample Number:	302-0660	Analyzed:	Feb 26, 1993
			Reported:	Mar 5, 1993

SEMI-VOLATILE ORGANICS by GC/MS (EPA 8270)

Analyte	Reporting Limit µg/L (ppb)	Sample Results µg/L (ppb)
Acenaphthene	20	N.D.
Acenaphthylene	20	N.D.
Aniline	20	N.D.
Anthracene	20	N.D.
Benzidine	500	N.D.
Benzoic Acid	100	N.D.
Benz[a]anthracene	20	N.D.
Benzo[b]fluoranthene	20	N.D.
Benzo[k]fluoranthene	20	N.D.
Benzo[g,h,i]perylene	20	N.D.
Benzo[a]pyrene	20	N.D.
Benzyl alcohol	20	N.D.
Bis(2-chloroethoxy)methane	20	N.D.
Bis(2-chloroethyl)ether	20	N.D.
Bis(2-chloroisopropyl)ether	20	N.D.
Bis(2-ethylhexyl)phthalate	100	N.D.
4-Bromophenyl phenyl ether	20	N.D.
Butyl benzyl phthalate	20	N.D.
Carbazole	20	N.D.
4-Chloroaniline	20	N.D.
2-Chloronaphthalene	20	N.D.
4-Chloro-3-methylphenol	20	N.D.
2-Chlorophenol	20	N.D.
4-Chlorophenyl phenyl ether	20	N.D.
Chrysene	20	N.D.
Dibenz[a,h]anthracene	20	N.D.
Dibenzofuran	20	N.D.
Di-n-butyl phthalate	100	N.D.
1,3-Dichlorobenzene	20	N.D.
1,4-Dichlorobenzene	20	N.D.
1,2-Dichlorobenzene	20	N.D.
3,3-Dichlorobenzidine	100	N.D.
2,4-Dichlorophenol	20	N.D.
Diethyl phthalate	20	N.D.
2,4-Dimethylphenol	20	N.D.
Dimethyl phthalate	20	N.D.
4,6-Dinitro-2-methylphenol	100	N.D.
2,4-Dinitrophenol	100	N.D.

NORTH CREEK ANALYTICAL

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CH2M Hill	Client Project ID:	Starkist, Samoa Inc.	Sampled:	Feb 17, 1993
777 108th Avenue NE	Sample Descript:	Water, ST	Received:	Feb 19, 1993
Bellevue, WA 98009	Analysis Method:	EPA 8270	Extracted:	Feb 23, 1993
Attention: David Wilson	Sample Number:	302-0660	Analyzed:	Feb 26, 1993
			Reported:	Mar 5, 1993

SEMI-VOLATILE ORGANICS by GC/MS (EPA 8270)

Analyte	Reporting Limit µg/L (ppb)	Sample Results µg/L (ppb)
2,4-Dinitrotoluene	20	N.D.
2,6-Dinitrotoluene	20	N.D.
Di-n-octyl phthalate	20	N.D.
Fluoranthene	20	N.D.
Fluorene	20	N.D.
Hexachlorobenzene	20	N.D.
Hexachlorobutadiene.	20	N.D.
Hexachlorocyclopentadiene	20	N.D.
Hexachloroethane	20	N.D.
Indeno[1,2,3-cd]pyrene	20	N.D.
Isophorone	20	N.D.
2-Methylnaphthalene	20	N.D.
2-Methylphenol	20	N.D.
4-Methylphenol	20	260
Naphthalene	20	N.D.
2-Nitroaniline	100	N.D.
3-Nitroaniline	100	N.D.
4-Nitroaniline	100	N.D.
Nitrobenzene	20	N.D.
2-Nitrophenol	20	N.D.
4-Nitrophenol	100	N.D.
N-Nitrosodiphenylamine	20	N.D.
N-Nitrosodi-n-propylamine	20	N.D.
Pentachlorophenol	100	N.D.
Phenanthrene	20	N.D.
Phenol	20	500
Pyrene	20	N.D.
1,2,4-Trichlorobenzene	20	N.D.
2,4,5-Trichlorophenol	100	N.D.
2,4,6-Trichlorophenol	20	N.D.

Surrogate Standards	Percent Recovery:	Control Limits	Surrogate Standards	Percent Recovery:	Control Limits
2-Fluorophenol	94	21-100	Nitrobenzene-d5	81	35-114
Phenol-d6	119	10-94	2-Fluorobiphenyl	77	43-116
2,4,6-Tribromophenol	88	10-123	p-Terphenyl-d14	101	33-141

Analytes reported as N.D. were not detected above the stated Reporting Limit. Because matrix effects and/or other factors required additional sample dilution, detection limits for this sample have been raised.

NORTH CREEK ANALYTICAL inc

Steven G. Mayer
Project Manager

3020660.CHM <2>

NORTH CREEK ANALYTICAL

18939 120th Avenue N.E., Suite 101· Bothell, WA 98011-2569
Phone (206) 481-9200 · FAX (206) 485-2992

CH2M Hill	Client Project ID:	Starkist, Samoa Inc.		
777 108th Avenue NE	Sample Descript:	Method Blank		
Bellevue, WA 98009	Analysis Method:	EPA 8270	Extracted:	Feb 18, 1993
Attention: David Wilson	Sample Number:	BLK021893	Analyzed:	Feb 23, 1993
			Reported:	Mar 5, 1993

SEMI-VOLATILE ORGANICS by GC/MS (EPA 8270)

Analyte	Reporting Limit µg/L (ppb)	Sample Results µg/L (ppb)
Acenaphthene	2.0	N.D.
Acenaphthylene	2.0	N.D.
Aniline	2.0	N.D.
Anthracene	2.0	N.D.
Benzidine	50	N.D.
Benzoic Acid	10	N.D.
Benz[a]anthracene	2.0	N.D.
Benzo[b]fluoranthene	2.0	N.D.
Benzo[k]fluoranthene	2.0	N.D.
Benzo[g,h,i]perylene	2.0	N.D.
Benzo[a]pyrene	2.0	N.D.
Benzyl alcohol	2.0	N.D.
Bis(2-chloroethoxy)methane	2.0	N.D.
Bis(2-chloroethyl)ether	2.0	N.D.
Bis(2-chloroisopropyl)ether	2.0	N.D.
Bis(2-ethylhexyl)phthalate	10	N.D.
4-Bromophenyl phenyl ether	2.0	N.D.
Butyl benzyl phthalate	2.0	N.D.
Carbazole	2.0	N.D.
4-Chloroaniline	2.0	N.D.
2-Chloronaphthalene	2.0	N.D.
4-Chloro-3-methylphenol	2.0	N.D.
2-Chlorophenol	2.0	N.D.
4-Chlorophenyl phenyl ether	2.0	N.D.
Chrysene	2.0	N.D.
Dibenz[a,h]anthracene	2.0	N.D.
Dibenzofuran	2.0	N.D.
Di-n-butyl phthalate	10	N.D.
1,3-Dichlorobenzene	2.0	N.D.
1,4-Dichlorobenzene	2.0	N.D.
1,2-Dichlorobenzene	2.0	N.D.
3,3-Dichlorobenzidine	10	N.D.
2,4-Dichlorophenol	2.0	N.D.
Diethyl phthalate	2.0	N.D.
2,4-Dimethylphenol	2.0	N.D.
Dimethyl phthalate	2.0	N.D.
4,6-Dinitro-2-methylphenol	10	N.D.
2,4-Dinitrophenol	10	N.D.

NORTH CREEK ANALYTICAL

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CH2M Hill	Client Project ID:	Starkist, Samoa Inc.		
777 108th Avenue NE	Sample Descript:	Method Blank		
Bellevue, WA 98009	Analysis Method:	EPA 8270	Extracted:	Feb 18, 1993
Attention: David Wilson	Sample Number:	BLK021893	Analyzed:	Feb 23, 1993
			Reported:	Mar 5, 1993

SEMI-VOLATILE ORGANICS by GC/MS (EPA 8270)

Analyte	Reporting Limit µg/L (ppb)	Sample Results µg/L (ppb)
2,4-Dinitrotoluene	2.0	N.D.
2,6-Dinitrotoluene	2.0	N.D.
Di-n-octyl phthalate	2.0	N.D.
Fluoranthene	2.0	N.D.
Fluorene	2.0	N.D.
Hexachlorobenzene	2.0	N.D.
Hexachlorobutadiene	2.0	N.D.
Hexachlorocyclopentadiene	2.0	N.D.
Hexachloroethane	2.0	N.D.
Indeno[1,2,3-cd]pyrene	2.0	N.D.
Isophorone	2.0	N.D.
2-Methylnaphthalene	2.0	N.D.
2-Methylphenol	2.0	N.D.
4-Methylphenol	2.0	N.D.
Naphthalene	2.0	N.D.
2-Nitroaniline	10	N.D.
3-Nitroaniline	10	N.D.
4-Nitroaniline	10	N.D.
Nitrobenzene	2.0	N.D.
2-Nitrophenol	2.0	N.D.
4-Nitrophenol	10	N.D.
N-Nitrosodiphenylamine	2.0	N.D.
N-Nitrosodi-n-propylamine	2.0	N.D.
Pentachlorophenol	10	N.D.
Phenanthrene	2.0	N.D.
Phenol	2.0	N.D.
Pyrene	2.0	N.D.
1,2,4-Trichlorobenzene	2.0	N.D.
2,4,5-Trichlorophenol	10	N.D.
2,4,6-Trichlorophenol	2.0	N.D.

Surrogate Standards	Percent Recovery:	Control Limits	Surrogate Standards	Percent Recovery:	Control Limits
2-Fluorophenol	77	21-100	Nitrobenzene-d5	68	35-114
Phenol-d6	88	10-94	2-Fluorobiphenyl	58	43-116
2,4,6-Tribromophenol	87	10-123	p-Terphenyl-d14	87	33-141

Analytes reported as N.D. were not detected above the stated Reporting Limit.

NORTH CREEK ANALYTICAL inc

Steven G. Mayer
Project Manager

NORTH CREEK ANALYTICAL

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Phone (206) 481-9200 · FAX (206) 485-2992

CH2M Hill	Client Project ID:	Starkist, Samoa Inc.	Sampled:	Feb 17, 1993
777 108th Avenue NE	Sample Descript:	Water, ST-01	Received:	Feb 19, 1993
Bellevue, WA 98009	Analysis Method:	EPA 8240/8260	Analyzed:	Mar 1, 1993
Attention: David Wilson	Sample Number:	302-0660	Reported:	Mar 5, 1993

VOLATILE ORGANICS by GC/MS (EPA 8240/8260)

Analyte	Reporting Limit µg/L (ppb)	Sample Results µg/L (ppb)
Acetone	**10**	**24**
Benzene	2.0	N.D.
Bromodichloromethane	2.0	N.D.
Bromoform	**2.0**	**6.4**
Bromomethane	2.0	N.D.
2-Butanone	10	N.D.
Carbon disulfide	2.0	N.D.
Carbon tetrachloride	2.0	N.D.
Chlorobenzene	2.0	N.D.
Chloroethane	2.0	N.D.
2-Chloroethyl vinyl ether	10	N.D.
Chloroform	2.0	N.D.
Chloromethane	2.0	N.D.
Dibromochloromethane	2.0	N.D.
1,1-Dichloroethane	2.0	N.D.
1,2-Dichloroethane	2.0	N.D.
1,1-Dichloroethene	2.0	N.D.
cis 1,2-Dichloroethene	2.0	N.D.
trans 1,2-Dichloroethene	2.0	N.D.
1,2-Dichloropropane	2.0	N.D.
cis 1,3-Dichloropropene	2.0	N.D.
trans 1,3-Dichloropropene	2.0	N.D.
Ethylbenzene	2.0	N.D.
2-Hexanone	10	N.D.
Methylene chloride	10	N.D.
4-Methyl-2-pentanone	10	N.D.
Styrene	2.0	N.D.
1,1,2,2-Tetrachloroethane	2.0	N.D.
Tetrachloroethene	2.0	N.D.
Toluene	2.0	N.D.
1,1,1-Trichloroethane	2.0	N.D.
1,1,2-Trichloroethane	2.0	N.D.
Trichloroethene	2.0	N.D.
Trichlorofluoromethane	2.0	N.D.
Vinyl chloride	2.0	N.D.
Total Xylenes	2.0	N.D.

Analytes reported as N.D. were not detected above the stated Reporting Limit.

NORTH CREEK ANALYTICAL inc

Steven G. Mayer
Project Manager

Surrogate Standards Percent Recovery:		Control Limits
1,2-Dichloroethane-d4	101	76-114
Toluene-d8	101	88-110
4-Bromofluorobenzene	92	86-115

NORTH CREEK ANALYTICAL

18939 120th Avenue N.E., Suite 101· Bothell, WA 98011-2569
Phone (206) 481-9200 · FAX (206) 485-2992

CH2M Hill	Client Project ID:	Starkist, Samoa Inc.		
777 108th Avenue NE	Sample Descript:	Method Blank		
Bellevue, WA 98009	Analysis Method:	EPA 8240/8260	Analyzed:	Mar 1, 1993
Attention: David Wilson	Sample Number:	BLK030193	Reported:	Mar 5, 1993

VOLATILE ORGANICS by GC/MS (EPA 8240/8260)

Analyte	Reporting Limit µg/L (ppb)	Sample Results µg/L (ppb)
Acetone	10	N.D.
Benzene	2.0	N.D.
Bromodichloromethane	2.0	N.D.
Bromoform	2.0	N.D.
Bromomethane	2.0	N.D.
2-Butanone	10	N.D.
Carbon disulfide	2.0	N.D.
Carbon tetrachloride	2.0	N.D.
Chlorobenzene	2.0	N.D.
Chloroethane	2.0	N.D.
2-Chloroethyl vinyl ether	10	N.D.
Chloroform	2.0	N.D.
Chloromethane	2.0	N.D.
Dibromochloromethane	2.0	N.D.
1,1-Dichloroethane	2.0	N.D.
1,2-Dichloroethane	2.0	N.D.
1,1-Dichloroethene	2.0	N.D.
cis 1,2-Dichloroethene	2.0	N.D.
trans 1,2-Dichloroethene	2.0	N.D.
1,2-Dichloropropane	2.0	N.D.
cis 1,3-Dichloropropene	2.0	N.D.
trans 1,3-Dichloropropene	2.0	N.D.
Ethylbenzene	2.0	N.D.
2-Hexanone	10	N.D.
Methylene chloride	10	N.D.
4-Methyl-2-pentanone	10	N.D.
Styrene	2.0	N.D.
1,1,2,2-Tetrachloroethane	2.0	N.D.
Tetrachloroethene	2.0	N.D.
Toluene	2.0	N.D.
1,1,1-Trichloroethane	2.0	N.D.
1,1,2-Trichloroethane	2.0	N.D.
Trichloroethene	2.0	N.D.
Trichlorofluoromethane	2.0	N.D.
Vinyl chloride	2.0	N.D.
Total Xylenes	2.0	N.D.

Analytes reported as N.D. were not detected above the stated Reporting Limit.

NORTH CREEK ANALYTICAL inc

Steven G. Mayer
Project Manager

Surrogate Standards Percent Recovery:		Control Limits
1,2-Dichloroethane-d4	100	76-114
Toluene-d8	98	88-110
4-Bromofluorobenzene	92	86-115

NORTH CREEK ANALYTICAL

18939 120th Avenue N.E., Suite 101· Bothell, WA 98011-2569
Phone (206) 481-9200 · FAX (206) 485-2992

CH2M Hill	Client Project ID:	Starkist, Samoa Inc.	Sampled:	Feb 17, 1993
777 108th Avenue NE	Sample Descript:	Water, ST	Received:	Feb 19, 1993
Bellevue, WA 98009	Analysis Method:	EPA 8080	Extracted:	Feb 22, 1993
Attention: David Wilson	Sample Number:	302-0660	Analyzed:	Feb 28, 1993
			Reported:	Mar 5, 1993

ORGANOCHLORINE PESTICIDES AND PCB'S (EPA 8080)

Analyte	Reporting Limit µg/L (ppb)	Sample Results µg/L (ppb)
Aldrin	0.10	N.D.
alpha-BHC	0.050	N.D.
beta-BHC	0.050	N.D.
delta-BHC	0.050	N.D.
gamma-BHC (Lindane)	0.40	N.D.
Chlordane	0.15	N.D.
4,4'-DDD	0.10	N.D.
4,4'-DDE	0.050	N.D.
4,4'-DDT	0.10	N.D.
Dieldrin	0.10	N.D.
Endosulfan I	0.15	N.D.
Endosulfan II	0.10	N.D.
Endosulfan sulfate	0.75	N.D.
Endrin	0.010	N.D.
Endrin aldehyde	0.25	N.D.
Heptachlor	0.10	N.D.
Heptachlor expoxide	0.10	N.D.
Methoxychlor	10	N.D.
Toxaphene	0.50	N.D.
PCB-1016	0.10	N.D.
PCB-1221	0.10	N.D.
PCB-1232	0.10	N.D.
PCB-1242	0.10	N.D.
PCB-1248	0.10	N.D.
PCB-1254	0.10	N.D.
PCB-1260	0.10	N.D.

Tetrachloro-m-xylene Surrogate Recovery, %: 50
Surrogate Recovery Control Limits are 16 - 104 %.
Analytes reported as N.D. were not detected above the stated Reporting Limit.

NORTH CREEK ANALYTICAL inc

Steven G. Mayer
Project Manager

NORTH CREEK ANALYTICAL

18939 120th Avenue N.E., Suite 101 · Bothell, WA 98011-2569
Phone (206) 481-9200 · FAX (206) 485-2992

CH2M Hill	Client Project ID:	Starkist, Samoa Inc.		
777 108th Avenue NE	Sample Descript:	Method Blank		
Bellevue, WA 98009	Analysis Method:	EPA 8080	Extracted:	Feb 22, 1993
Attention: David Wilson	Sample Number:	BLK022293	Analyzed:	Feb 28, 1993
			Reported:	Mar 5, 1993

ORGANOCHLORINE PESTICIDES AND PCB'S (EPA 8080)

Analyte	Reporting Limit µg/L (ppb)	Sample Results µg/L (ppb)
Aldrin	0.10	N.D.
alpha-BHC	0.050	N.D.
beta-BHC	0.050	N.D.
delta-BHC	0.050	N.D.
gamma-BHC (Lindane)	0.40	N.D.
Chlordane	0.15	N.D.
4,4'-DDD	0.10	N.D.
4,4'-DDE	0.050	N.D.
4,4'-DDT	0.10	N.D.
Dieldrin	0.10	N.D.
Endosulfan I	0.15	N.D.
Endosulfan II	0.10	N.D.
Endosulfan sulfate	0.75	N.D.
Endrin	0.010	N.D.
Endrin aldehyde	0.25	N.D.
Heptachlor	0.10	N.D.
Heptachlor expoxide	0.10	N.D.
Methoxychlor	10	N.D.
Toxaphene	0.50	N.D.
PCB-1016	0.10	N.D.
PCB-1221	0.10	N.D.
PCB-1232	0.10	N.D.
PCB-1242	0.10	N.D.
PCB-1248	0.10	N.D.
PCB-1254	0.10	N.D.
PCB-1260	0.10	N.D.

Tetrachloro-m-xylene Surrogate Recovery, %: 64
Surrogate Recovery Control Limits are 16 - 104 %.
Analytes reported as N.D. were not detected above the stated Reporting Limit.

NORTH CREEK ANALYTICAL inc

Steven G. Mayer
Project Manager

NORTH CREEK ANALYTICAL

18939 120th Avenue N.E., Suite 101· Bothell, WA 98011-2569
Phone (206) 481-9200 · FAX (206) 485-2992

CH2M Hill	Client Project ID:	Starkist, Samoa Inc.	Sampled:	Feb 17, 1993
777 108th Avenue NE	Analysis Method:	EPA 9010	Received:	Feb 19, 1993
Bellevue, WA 98009	Analysis for:	Total Cyanide	Analyzed:	Feb 22, 1993
Attention: David Wilson	First Sample #:	302-0660	Reported:	Mar 5, 1993

LABORATORY ANALYSIS FOR: Total Cyanide

Sample Number	Sample Description	Reporting Limit mg/L (ppm)	Sample Result mg/L
302-0660	ST	0.010	N.D.
BLK022293	Method Blank	0.010	N.D.

Analytes reported as N.D. were not detected above the stated Reporting Limit.

NORTH CREEK ANALYTICAL inc

Steven G. Mayer
Project Manager

NORTH CREEK ANALYTICAL

18939 120th Avenue N.E., Suite 101 · Bothell, WA 98011-2569
Phone (206) 481-9200 · FAX (206) 485-2992

CH2M Hill	Client Project ID:	Starkist, Samoa Inc.	Sampled:	Feb 17, 1993
777 108th Avenue NE	Sample Descript:	ST	Received:	Feb 19, 1993
Bellevue, WA 98009	Matrix:	Water	Digested:	Feb 22-24, 1993
Attention: David Wilson	Sample Number:	302-0660	Analyzed:	Feb 24-26, 1993
			Reported:	Mar 5, 1993

METALS ANALYSIS

Analyte	EPA Method	Reporting Limit µg/L (ppb)	Sample Results µg/L (ppb)
Antimony	6010	100	N.D.
Arsenic	7060	5.0	6.0
Beryllium	6010	10	N.D.
Cadmium	6010	5.0	N.D.
Chromium	6010	20	N.D.
Copper	6010	10	N.D.
Lead	7421	2.0	N.D.
Mercury	7470 Mod.	100	N.D.
Nickel	6010	50	N.D.
Selenium	6010	100	N.D.
Silver	7760	20	130
Thallium	6010	100	N.D.
Zinc	6010	40	92

Analytes reported as N.D. were not detected above the stated Reporting Limit.

NORTH CREEK ANALYTICAL inc

Steven G. Mayer
Project Manager

NORTH CREEK ANALYTICAL

18939 120th Avenue N.E., Suite 101 · Bothell, WA 98011-2569
Phone (206) 481-9200 · FAX (206) 485-2992

CH2M Hill	Client Project ID:	Starkist, Samoa Inc.	
777 108th Avenue NE	Sample Descript:	Method Blank	
Bellevue, WA 98009	Matrix:	Water	Digested: Feb 22, 1993
Attention: David Wilson	Sample Number:	BLK022293	Analyzed: Feb 24-26, 1993
			Reported: Mar 5, 1993

METALS ANALYSIS

Analyte	EPA Method	Reporting Limit µg/L (ppb)		Sample Results µg/L (ppb)
Antimony	6010	100		N.D.
Arsenic	7060	5.0		N.D.
Beryllium	6010	10		N.D.
Cadmium	6010	5.0		N.D.
Chromium	6010	20		N.D.
Copper	6010	10		N.D.
Lead	7421	2.0		N.D.
Mercury	7470 Mod.	100		N.D.
Nickel	6010	50		N.D.
Selenium	6010	100		N.D.
Silver	7760	20		N.D.
Thallium	6010	100		N.D.
Zinc	6010	40		N.D.

Analytes reported as N.D. were not detected above the stated Reporting Limit.

NORTH CREEK ANALYTICAL inc

Steven G. Mayer
Project Manager

NORTH CREEK ANALYTICAL

18939 120th Avenue N.E., Suite 101· Bothell, WA 98011-2569
Phone (206) 481-9200 · FAX (206) 485-2992

CH2M Hill	Client Project ID: Starkist, Samoa Inc.	Analyst: J. Cooper
777 108th Avenue NE	Method: EPA 8080	
Bellevue, WA 98009	Sample Matrix : Water	Extracted: Feb 22, 1993
Attention: David Wilson	Units: µg/L (ppb)	Analyzed: Feb 28, 1993
	QC Sample #: 302-0660	Reported: Mar 5, 1993

MATRIX SPIKE QUALITY CONTROL DATA REPORT

ANALYTE	Lindane	Heptachlor	Aldrin
Sample Result:	N.D.	N.D.	N.D.
Spike Conc. Added:	0.66	0.66	0.66
Spike Result:	0.54	0.46	0.48
Spike % Recovery:	82%	70%	73%
Spike Dup. Result:	0.53	0.50	0.47
Spike Duplicate % Recovery:	80%	76%	71%
Upper Control Limit %:	128	163	121
Lower Control Limit %:	37	60	60
Relative % Difference:	1.9%	8.7%	2.1%
Maximum RPD:	50	50	50

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Steven G. Mayer
Project Manager

% Recovery:	$\frac{\text{Spike Result - Sample Result}}{\text{Spike Conc. Added}}$	x 100
Relative % Difference:	$\frac{\text{Spike Result - Spike Dup. Result}}{\text{(Spike Result + Spike Dup. Result) / 2}}$	x 100

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18939 120th Avenue N.E., Suite 101 · Bothell, WA 98011-2569
Phone (206) 481-9200 · FAX (206) 485-2992

CH2M Hill	Client Project ID: Starkist, Samoa Inc.	Analyst:	J. Kimball
777 108th Avenue NE	Method: EPA 8240		
Bellevue, WA 98009	Sample Matrix : Water		
Attention: David Wilson	Units: µg/L (ppb)	Analyzed:	Mar 1, 1993
	QC Sample #: 302-0515	Reported:	Mar 5, 1993

MATRIX SPIKE QUALITY CONTROL DATA REPORT

ANALYTE	1,1-DCE	Benzene	TCE	Toluene	Chloro-benzene
Sample Result:	N.D.	N.D.	N.D.	N.D.	N.D.
Spike Conc. Added:	10	10	10	10	10
Spike Result:	11	9.7	10	11	9.8
Spike % Recovery:	110%, Q-1	97%	100%	110%	98%
Spike Dup. Result:	9.7	9.6	9.8	10	9.9
Spike Duplicate % Recovery:	97%	96%	98%	100%	99%
Upper Control Limit %:	107	118	106	122	111
Lower Control Limit %:	69	83	81	66	86
Relative % Difference:	12.6%	1.0%	2.0%	9.5%	1.0%
Maximum RPD:	17	9.0	13	10	7.0

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Steven G. Mayer
Project Manager

Please Note:
Q-1 = The Spike Recovery for this QC sample is outside of the NCA established control limits.

NORTH CREEK ANALYTICAL

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Phone (206) 481-9200 · FAX (206) 485-2992

CH2M Hill
777 108th Avenue NE
Bellevue, WA 98009
Attention: David Wilson

Client Project ID: Starkist, Samoa Inc.
Sample Matrix : Water
Units: mg/L (ppm)

Analyst: R. Davies

Reported: Mar 5, 1993

INORGANIC QUALITY CONTROL DATA REPORT

ANALYTE
CN

EPA Method: 9010
Date Analyzed: Feb 22, 1993

ACCURACY ASSESSMENT

LCS Spike Conc. Added:	0.40
LCS Spike Result:	0.41
LCS Spike % Recovery:	103
Upper Control Limit:	125
Lower Control Limit:	75

PRECISION ASSESSMENT

Sample #:	302-0660
Original:	N.D.
Duplicate:	N.D.
Relative % Difference:	RPD values are not reported at sample concentration levels < 5 X the Reporting Limit.
Maximum RPD:	25

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Steven G. Mayer
Project Manager

Lab Control Sample % Recovery: $\frac{\text{Conc. of L.C.S.}}{\text{L.C.S. Spike Conc. Added}} \times 100$

Relative % Difference: $\frac{\text{Original Result - Duplicate Result}}{(\text{Original Result + Duplicate Result}) / 2} \times 100$

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Phone (206) 481-9200 · FAX (206) 485-2992

CH2M Hill	Client Project ID: Starkist, Samoa Inc.	Analyst :	G. Emory
777 108th Avenue NE	Method : EPA 8270		
Bellevue, WA 98009	Sample Matrix : Water	Extracted:	Feb 23, 1993
Attention: David Wilson	Units : µg/L (ppb)	Analyzed:	Feb 25, 1993
	QC Sample #: BLK022393	Reported:	Mar 5, 1993

BLANK SPIKE QUALITY CONTROL DATA REPORT

Analyte	Sample Result	Spike Conc. Added	Spike Result	Spike % Recovery	Spike Dup. Result	Spike Duplicate % Recovery	Relative % Difference
Phenol	N.D.	200	160	80% (12 -110%)	160	80% (12 -110%)	0.0% (42%)
2-Chlorophenol	N.D.	200	140	70% (27 -123%)	140	70% (27 -123%)	0.0% (40%)
1,4-Dichloro-benzene	N.D.	100	54	54% (36 -97%)	59	59% (36 -97%)	8.8% (40%)
N-Nitroso-Di-N-propylamine	N.D.	100	90	90% (41 -116%)	92	92% (41 -116%)	2.2% (38%)
1,2,4-Trichloro-benzene	N.D.	100	61	61% (39 -98%)	64	64% (39 -98%)	4.8% (28%)
4-Chloro-3-Methylphenol	N.D.	200	130	65% (23 -97%)	130	65% (23 -97%)	0.0% (42%)
Acenaphthene	N.D.	100	65	65% (46 -118%)	64	64% (46 -118%)	1.6% (31%)
4-Nitrophenol	N.D.	200	180	90% (10 -80%)	170	85% (10 -80%)	5.7% (50%)
2,4-Dinitro-toluene	N.D.	100	84	84% (24 -96%)	83	83% (24 -96%)	1.2% (38%)
Pentachloro-phenol	N.D.	200	160	80% (9 -103%)	160	80% (9 -103%)	0.0% (50%)
Pyrene	N.D.	100	86	86% (26 -127%)	84	84% (26 -127%)	2.4% (31%)

Control Limits in Parentheses

NORTH CREEK ANALYTICAL inc

Steven G. Mayer
Project Manager

$$\%\ \text{Recovery:} = \frac{\text{Spike Result - Sample Result}}{\text{Spike Conc. Added}} \times 100$$

$$\text{Relative \% Difference:} = \frac{\text{Spike Result - Spike Dup. Result}}{\text{(Spike Result + Spike Dup. Result) / 2}} \times 100$$

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18939 120th Avenue N.E., Suite 101 · Bothell, WA 98011-2569
Phone (206) 481-9200 · FAX (206) 485-2992

CH2M Hill
777 108th Avenue NE
Bellevue, WA 98009
Attention: David Wilson

Client Project ID: Starkist, Samoa Inc.
Sample Matrix : Water
Units: µg/L (ppb)

Analyst: B. Oaks

Digested: Feb 24, 1993
Reported: Mar 5, 1993

METALS QUALITY CONTROL DATA REPORT

ANALYTE	Arsenic	Lead
EPA Method:	7060	7421
Date Analyzed:	2/24/93	2/24/93
ACCURACY ASSESSMENT		
LCS Spike Conc. Added:	50	25
LCS Spike Result:	59	26
LCS Spike % Recovery:	98	104
Upper Control Limit:	121	114
Lower Control Limit:	80	82
Matrix Spike Sample #:	302-0647	302-0647
Matrix Spike % Recovery:	104	82
PRECISION ASSESSMENT		
Sample #:	302-0647	302-0647
Original:	12	3.4
Duplicate:	12	3.2
Relative % Difference:	Q4	Q4

NORTH CREEK ANALYTICAL inc

Steven G. Mayer
Project Manager

Please Note:
Q4 = Relative Percent Difference values are not reported at sample concentrations less than ten times the Reporting Limit.

NORTH CREEK ANALYTICAL

18939 120th Avenue N.E., Suite 101· Bothell, WA 98011-2569
Phone (206) 481-9200 · FAX (206) 485-2992

CH2M Hill
777 108th Avenue NE
Bellevue, WA 98009
Attention: David Wilson

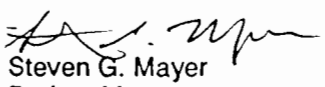
Client Project ID: Starkist, Samoa Inc.
Sample Matrix : Water
Units: µg/L (ppb)

Analyst: B. Oaks
Digested: Feb 21, 1993
Reported: Mar 5, 1993

METALS QUALITY CONTROL DATA REPORT

ANALYTE	Antimony	Beryllium	Cadmium	Chromium	Copper	Nickel	Selenium
EPA Method:	6010	6010	6010	6010	6010	6010	6010
Date Analyzed:	2/24/93	2/24/93	2/24/93	2/24/93	2/24/93	2/24/93	2/24/93
ACCURACY ASSESSMENT							
LCS Spike Conc. Added:	1000	1000	1000	1000	1000	1000	1000
LCS Spike Result:	940	970	910	930	940	940	800
LCS Spike % Recovery:	94	97	91	93	94	94	80
Upper Control Limit:	104	117	104	120	112	130	104
Lower Control Limit:	82	77	69	65	74	57	65
Matrix Spike Sample #:	302-0713	302-0713	302-0713	302-0713	302-0713	302-0713	302-0713
Matrix Spike % Recovery:	92	97	90	92	98	93	79
PRECISION ASSESSMENT							
Sample #:	302-0713	302-0713	302-0713	302-0713	302-0713	302-0713	302-0713
Original:	N.D.	N.D.	N.D.	N.D.	35	N.D.	N.D.
Duplicate:	N.D.	N.D.	N.D.	N.D.	38	N.D.	N.D.
Relative % Difference:	Q4	Q4	Q4	Q4	Q4	Q4	Q4

NORTH CREEK ANALYTICAL inc



Steven G. Mayer
Project Manager

Please Note:
Q4 = Relative Percent Difference values are not reported at sample concentrations less than ten times the Reporting Limit.

NORTH CREEK ANALYTICAL

18939 120th Avenue N.E., Suite 101· Bothell, WA 98011-2569
Phone (206) 481-9200 · FAX (206) 485-2992

CH2M Hill
777 108th Avenue NE
Bellevue, WA 98009
Attention: David Wilson

Client Project ID: Starkist, Samoa Inc.
Sample Matrix : Water
Units: µg/L (ppb)

Analyst: B. Oaks
Digested: Feb 21, 1993
Reported: Mar 5, 1993

METALS QUALITY CONTROL DATA REPORT

ANALYTE	Thallium	Zinc	Silver	Mercury
EPA Method:	6010	6010	7760	6010
Date Analyzed:	2/24/93	2/24/93	2/25/93	2/25/93
ACCURACY ASSESSMENT				
LCS Spike Conc. Added:	1000	1000	1000	5.0
LCS Spike Result:	890	910	110	4.7
LCS Spike % Recovery:	89	91	110	94
Upper Control Limit:	112	119	117	123
Lower Control Limit:	54	71	87	82
Matrix Spike Sample #:	302-0713	302-0713	302-0713	302-0661
Matrix Spike % Recovery:	92	91	110	86
PRECISION ASSESSMENT				
Sample #:	302-0713	302-0713	302-0713	302-0661
Original:	N.D.	N.D.	N.D.	N.D.
Duplicate:	N.D.	N.D.	N.D.	N.D.
Relative % Difference:	Q4	Q4	Q4	Q4

NORTH CREEK ANALYTICAL inc

Steven G. Mayer
Project Manager

Please Note:
Q4 = Relative Percent Difference values are not reported at sample concentrations less than ten times the Reporting Limit.

MED-TOX NORTHWEST

LABORATORY REPORT

North Creek Analytical
18939 - 120th Avenue NE, #101
Bothell, Washington 98011-2569

Samples Received: 2/22/93
Samples Analyzed: 2/24/93
Date Reported: 2/24/93
MED-TOX Job No: 1L-2836(1)

Attn: Matt Essig

ANALYSIS: ASBESTOS IN BULK SAMPLES

METHOD: PLM (POLARIZED LIGHT MICROSCOPY/DISPERSION STAINING)
EPA 600/M4-82-020

Sample I.D. Client Lab No.	Asbestos Percent	Brief Physical Description
Starkist		
3020660	ND(1)	Homogeneous beige fine-grained material: 5% cellulose, fine particles, binder.

Carol Olver
Laboratory Analyst

2/26/93
Date

Carol Olver
Laboratory Manager
NVLAP Signatory

NIST NVLAP Participant Number 2021
* PLEASE SEE ESSENTIAL NOTES ON FOLLOWING PAGE
Samples are archived for two months following analysis. Samples that are not retrieved by the client after two months are discarded.

LAB 1L-2836.L01 2/25/93

NOTES:

- "ND(1)" means no asbestos detected; method limit of quantification is 1%.
- "Trace" means less than 1% asbestos material was identified in the sample; the EPA considers materials that contain less than 1% asbestos not to be a hazard.
- "SS(2)" means small sample size; may not be representative of sampled material.
- Each sample was examined for all asbestos minerals (i.e., chrysotile, amosite, crocidolite, anthophyllite, tremolite, and actinolite); but only those asbestos minerals detected are listed.
- Soils, vinyl floor tiles, and slurry-based materials (e.g., spray-on and troweled-on materials) can be inhomogeneous due to the nature of their preparation. Quality control checks are performed on 10% of the sample load to help ensure the accuracy of data.
- Tile, mastic, vinyl, foam, plastic, and fine powder samples may contain asbestos fibers which are too small to be detected by PLM. For such samples more sensitive analytical methods (e.g., XRD, TEM, SEM) are recommended if greater certainty of the presence and quantity of asbestos minerals.
- The coefficient of variance for PLM asbestos samples typically ranges from 0.10 to 0.50.
- Samples are archived 60 days following analysis and then properly disposed of as hazardous waste.
- This report verifies, with respect to asbestos content, only the samples analyzed.
- This test report is not valid unless it bears the name of a NVLAP approved signatory.
- Any reproduction of this document must include the entire document in order to be valid.
- Neither the NVLAP accreditation of this laboratory nor this report can be used to claim product endorsement by NVLAP or any agency of the U.S. Government.
- The laboratory is not accountable for the completeness with which a sample represents the actual material for samples not collected by Med-Tox Northwest personnel.
- For samples containing >0 but $<10\%$ asbestos, point counting by the PLM method is recommended by the EPA (NESHAPS, 40 CFR Part 61).

California Analytical
Laboratory

March 8, 1993
Lab ID: 068319

Enseco
A Corning Company

Beth Neely
North Creek Analytical, Inc.
18939 120th Ave. NE, Suite 101
Bothell, WA 98011-2569

Dear Ms. Neely:

Enclosed is the report for the 2,3,7,8-TCDD/TCDF analysis of your two aqueous samples which were received at Enseco Cal Lab on 23 February 1993 under chain-of-custody.

Detection limits are reported on a sample specific basis and all results are recovery corrected per the isotope dilution technique for dioxin/furan analyses. The method blank is a laboratory-generated sample which assesses the degree to which laboratory operations and procedures cause false-positive analytical results for your samples.

For pulp and paper industry samples, test methods for chlorinated dioxin/furan analyses will follow NCASI Technical Bulletin 551 unless otherwise noted. Pulp and sludge samples are air dried and prepared per this method. All results for these analyses, including detection limits, are reported on a dry weight basis.

All other solid and waste samples are reported on an "as received" basis, i.e., no correction is made for moisture content, unless the method requires or the client requests that such correction be made.

Results are on the attached data sheets.

If you have any questions, please feel free to call.

Sincerely,

Mark Bechthold
Scientist
Advanced Technology Group

Kathleen A. Gill
Program Administrator

jk

Enseco - CAL
2544 Industrial Blvd.
West Sacramento, CA 95691-3435
(916) 372-1393
FAX: (916) 372-7768

SAMPLE DESCRIPTION INFORMATION
for
North Creek Analytical, Inc.

Lab ID	Client ID	Matrix	Sampled Date	Sampled Time	Received Date
68319-0001-SA	3020660	AQUEOUS	17 FEB 93	12:00	23 FEB 93
68319-0001-MS	3020660	AQUEOUS	17 FEB 93	12:00	23 FEB 93
068319-0001-SD	3020660	AQUEOUS	17 FEB 93	12:00	23 FEB 93
068319-0001-MB	Method Blank	AQUEOUS			23 FEB 93

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HIGH RESOLUTION

Client Name: North Creek Analytical, Inc.
Client ID: 3020660
Lab ID: 068319-0001-SA
Matrix: AQUEOUS Sampled: 17 FEB 93 Received: 23 FEB 93
Authorized: 24 FEB 93 Prepared: 28 FEB 93

Sample Amount 0.502 L

Parameter	Result	Units	Detection Limit	Data Qualifiers
Furans				
Column Type: DB-225				
Analyzed: 05 MAR 93				
2,3,7,8-TCDF	ND	pg/L	5.2	
Dioxins				
Column Type: DB-225				
Analyzed: 05 MAR 93				
2,3,7,8-TCDD	ND	pg/L	9.9	
	% Recovery			
13C-2,3,7,8-TCDF	37			
13C-2,3,7,8-TCDD	37			

ND = Not detected
NA = Not applicable

Reported By: Saleh Arghestani Approved By: Jill Kellmann

The cover letter is an integral part of this report.
Rev 230787

Enseco
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HIGH RESOLUTION

Client Name: North Creek Analytical, Inc.
Client ID: Method Blank
Lab ID: 068319-0001-MB
Matrix: AQUEOUS Sampled: NA Received: NA
Authorized: 24 FEB 93 Prepared: 28 FEB 93

Sample Amount 1.000 L

Parameter	Result	Units	Detection Limit	Data Qualifiers
Furans				
Column Type: DB-225				
Analyzed: 05 MAR 93				
2 3,7,8-TCDF	ND	pg/L	1.5	
Dioxins				
Column Type: DB-225				
Analyzed: 05 MAR 93				
2 3,7,8-TCDD	ND	pg/L	3.7	
	% Recovery			
13C-2,3,7,8-TCDF	39			
13C-2,3,7,8-TCDD	38			

ND = Not detected
NA = Not applicable

Reported By: Saleh Arghestani Approved By: Jill Kellmann

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2,3,7,8-TCDD/TCDF

QUALITY CONTROL SUMMARY

Client Name: North Creek analytical, Inc.
Client ID: 3020660 Matrix Spike
Lab ID: 068319-0001-MS
Matrix: AQUEOUS Sampled: 17 FEB 93 Received: 23 FEB 93
Authorized: 23 FEB 93 Prepared: 28 FEB 93 Analyzed: 05 MAR 93

Sample Amount: 0.500 L
Column Type: DB-225

Parameters	pg/uL Found in Sample	pg/uL Spiked	pg/uL Found in MS Sample	% Recovery
Furans				
2,3,7,8-TCDF	ND	25	30.0	120
Dioxins				
2,3,7,8-TCDD	ND	10	10.8	108

	% Recovery
13C-2,3,7,8-TCDF	60
13C-2,3,7,8-TCDD	62

ND=Not Detected
NA=Not Applicable

Reported by: Saleh Arghestani Approved by: Jill Kellmann

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2,3,7,8-TCDD/TCDF

QUALITY CONTROL SUMMARY

Client Name: North Creek analytical, Inc.
Client ID: 3020660 Matrix Spike Duplicate
Lab ID: 068319-0001-SD
Matrix: AQUEOUS Sampled: 17 FEB 93 Received: 23 FEB 93
Authorized: 23 FEB 93 Prepared: 28 FEB 93 Analyzed: 05 MAR 93

Sample Amount: 0.502 L
Column Type: DB-225

Parameters	pg/uL Found in Sample	pg/uL Spiked	pg/uL Found in MS Sample	% Recovery
Furans				
2,3,7,8-TCDF	ND	25	30.0	120
Dioxins				
2,3,7,8-TCDD	ND	10	11.0	110

	% Recovery
13C-2,3,7,8-TCDF	53
13C-2,3,7,8-TCDD	53

ND=Not Detected
NA=Not Applicable

Reported by: Saleh Arghestani Approved by: Jill Kellmann

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